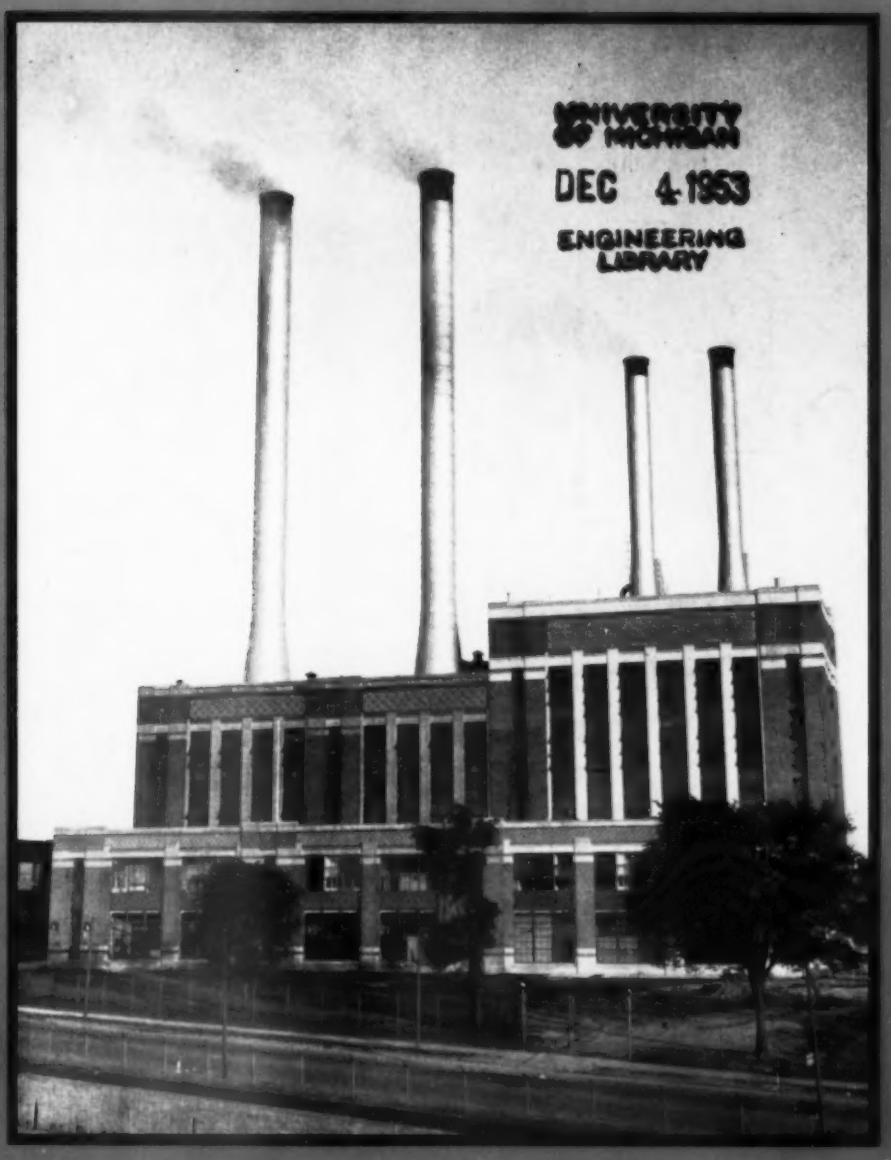
COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

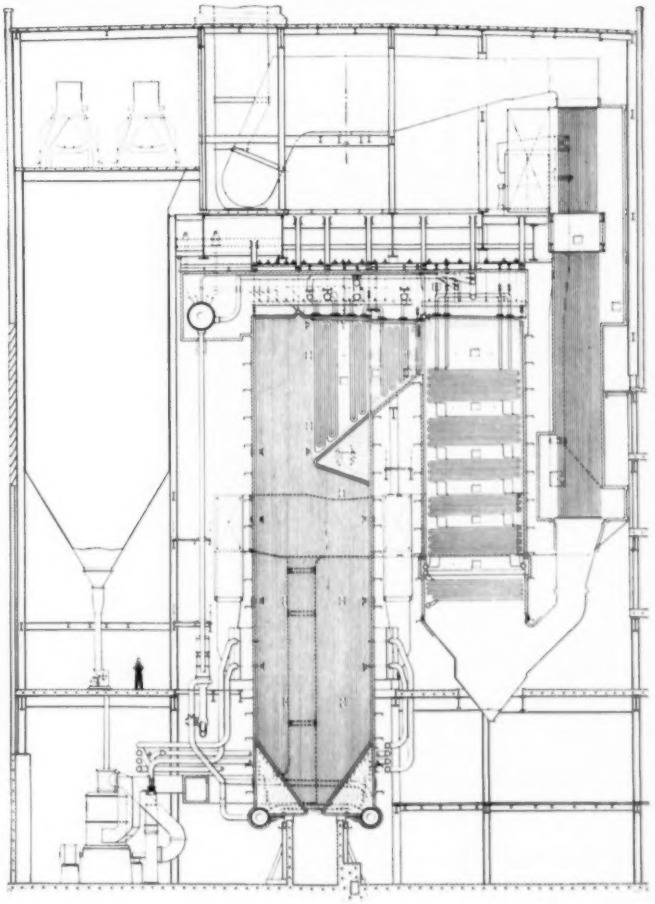
November 1953



The Ford Motor Company of Canada at Windsor, Ontario, recently completed an extension to its plant as shown at the right.

JOHN C. WEADOCK PLANT

Consumers Power Company



C-E controlled circulation boilers

The C-E Unit shown above is presently in process of fabrication for the John C. Weadock Plant of Consumers Power Company at Essexville, Michigan. Commonwealth Associates, Inc., are the Consulting Engineers.

It is designed to serve a 135,000 kw turbine-generator, operating at a throttle pressure of 2000 psi with a primary steam temperature of 1050 F, reheated to 1000 F.

The unit is of the controlled-circulation, radiant, reheat type with a divided furnace. The reheater surface is located between the primary and secondary superheater sections, and economizer surface is located below the rear superheater section. A tubular type air heater follows the economizer surface.

Pulverized coal firing is employed, using bowl mills and tilting, tangential burners.

B-709

COMBUSTION ENGINEERING, INC.

Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT

COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

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Feature Articles

Editorials

Departments

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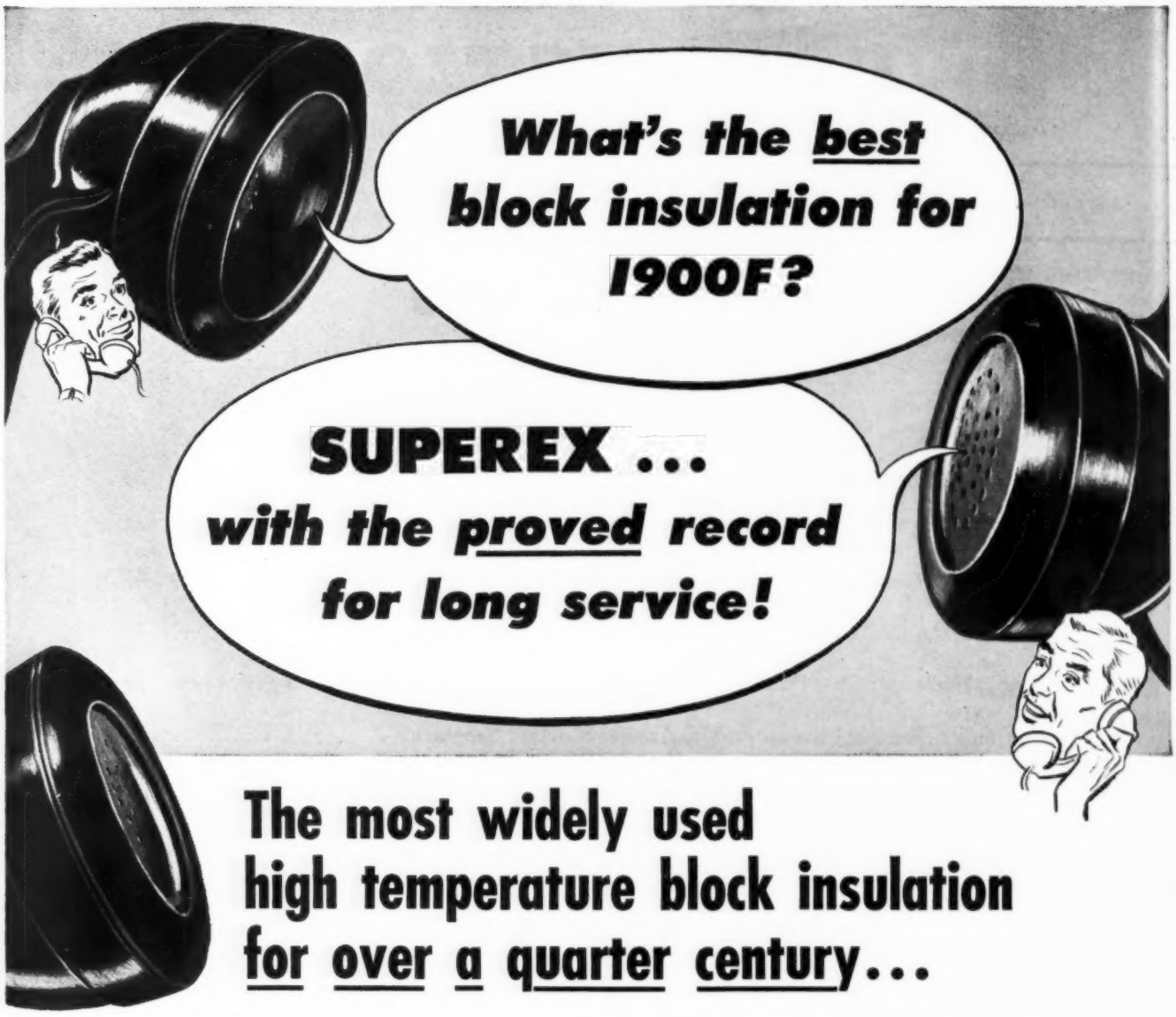

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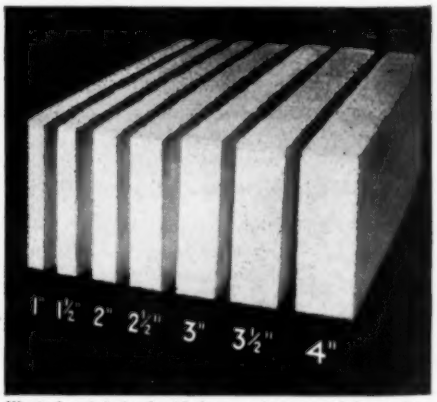

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Editorials

Conserving Engineering Manpower

That steps to conserve engineering manpower may be undertaken in a number of areas was demonstrated by several speakers at the joint sessions of the American Society for Engineering Education and the Engineers' Council for Professional Development held in New York on October 14–17. Opportunities exist to improve the selection of those who wish to become engineers, to stimulate higher levels of creativity (and therefore the quality of work) through new techniques of teaching, and to make better use of engineers' talents following graduation.

The basic problem of engineering manpower is a long range rather than an immediate one. It is related to the percentage of population having the intellectual capabilities of entering the professions. In effect, research begets new specialties which require additional workers. The long run demand for professional personnel appears to exceed the percentage of persons mentally qualified to practice the professions. The task for engineering is one of getting its share of available manpower and then using that share as efficiently and effectively as possible.

Attracting intellectually qualified high school students to engineering is the first stage. This is largely a guidance function about which there is some question concerning effectiveness to date. Gregory Dexter, a consulting engineer who addressed the joint meeting, expressed the belief that engineering schools do not give prospective students enough information about educational costs. He urged that such information be made more generally available and advocated wider use of College Board entrance examinations to weed out those not qualified for engineering.

Among those who study engineering there is a small group whose contributions to the profession are far in excess of their numbers. It was therefore fitting that one day of the joint conference was devoted to a consideration of the nature of creativity and ways in which it can be stimulated. With more knowledge of the creative process it may be possible for those having the highest capabilities to make even more outstanding contributions to the profession.

Upon graduation the young engineer needs further guidance. Professor C. Wandmacher told of a pilot project being conducted in Cincinnati to aid the young engineer in his orientation to community and industrial life. If successful, the program is to be placed in operation in other cities where it is felt that it can be of assistance in guiding professional development and reducing the number who drift away from engineering early in their careers.

Another way of conserving engineering manpower is to keep engineers employed at engineering jobs. Guy Kleis of Westinghouse Electric Corp. told of a three-point program by his organization to release engineers from fringe-area jobs, to purify engineering jobs of extraneous non-professional duties and to raise performance levels through educational assistance.

The problem of engineering manpower must be viewed in long time perspective. Over the short run there may be some instances in which there is a surplus of engineers. But the broad picture as painted at the joint ASEE-ECPD meeting is one that must not be lost sight of. It represents a problem that the engineering profession must be willing to face for years to come.

Coal Vs. Foreign Oil

The coal industry has for some time been much perturbed over the large importations of foreign oil, and when the Congress convenes in January it is anticipated that strong pressure will be brought to bear for passage of the Simpson Bill, which aims to limit such importations.

Since most large steam generating units are now designed to burn either pulverized coal or oil, except for areas in which natural gas abounds, it is reasonable to expect operators to take full advantage of the competitive positions of oil and coal. This is reflected in the figures on fuel consumption that are compiled regularly by the Federal Power Commission showing an ever-increasing use of fuel oil and gas. Despite this, they also show a moderate increase in coal consumption by electric utilities.

Unlike the oil industry, the coal industry has been periodically harassed by labor demands and strikes and now has to contend with a substantial increase in freight rates. Thus far, John L. Lewis is apparently marking time as to his next demands, probably with an eye to the disposition of the Simpson Bill.

Supporters of the proposed legislation argue that inasmuch as coal is our basic fuel it must not be permitted to become a reserve for oil and gas if a healthy coal industry is to survive. Moreover, they point out that coal is at present our only source of energy having the ability to expand production to meet the requirements of a national emergency. This appears to be sound logic.

On the other hand, there are those who contend that passage of the bill would result in further labor demands with consequent advancing fuel prices and another competitive cycle at a higher price level.

During the last decade the coal industry has made marked progress in research and mining methods. As Secretary of the Interior Douglas McKay recently pointed out, its sustained prosperity is vital to our economy and it must not be permitted to become an object of Government control and subsidy.

New Boilers for DOMINO SUGAR

By SPENCER FLOURNOY

Mechanical Engineer, Baker & Spencer, Inc. affiliated with Frederic R. Harris, Inc.

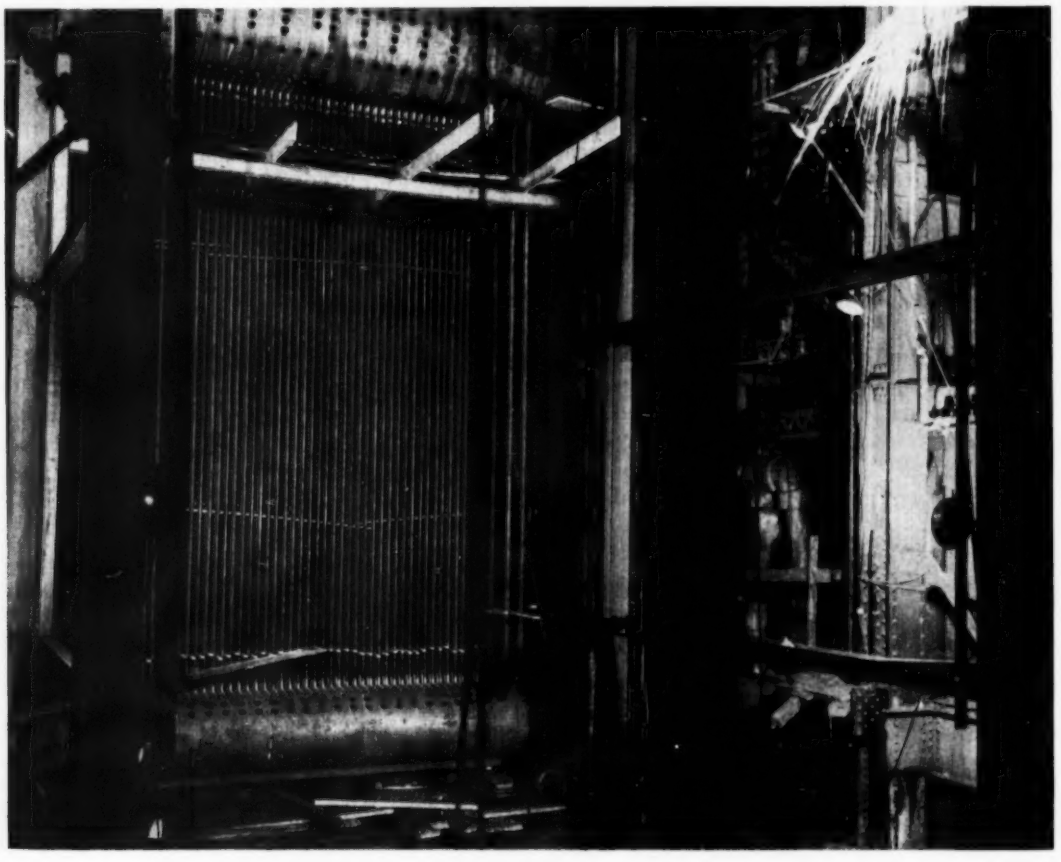
This plant originally contained 24 boilers operating at 200 psig. Present steam demands are met by two 150,000-lb-per-hr, 400-psig, 600-F boilers which supply three 1500-kw back-pressure turbine-generators. Makeup is 100 per cent. Construction was complicated by the necessity of keeping the old boilers in service while installing the new units in limited space.

IT takes a lot of steam to refine four million pounds of raw sugar per day, and a lot of power. Steam and power cost money and must be dependable. With this in mind, the American Sugar Refining Company undertook a program of power plant modernization in 1945, retaining Baker & Spencer, Inc., as consulting engineers.

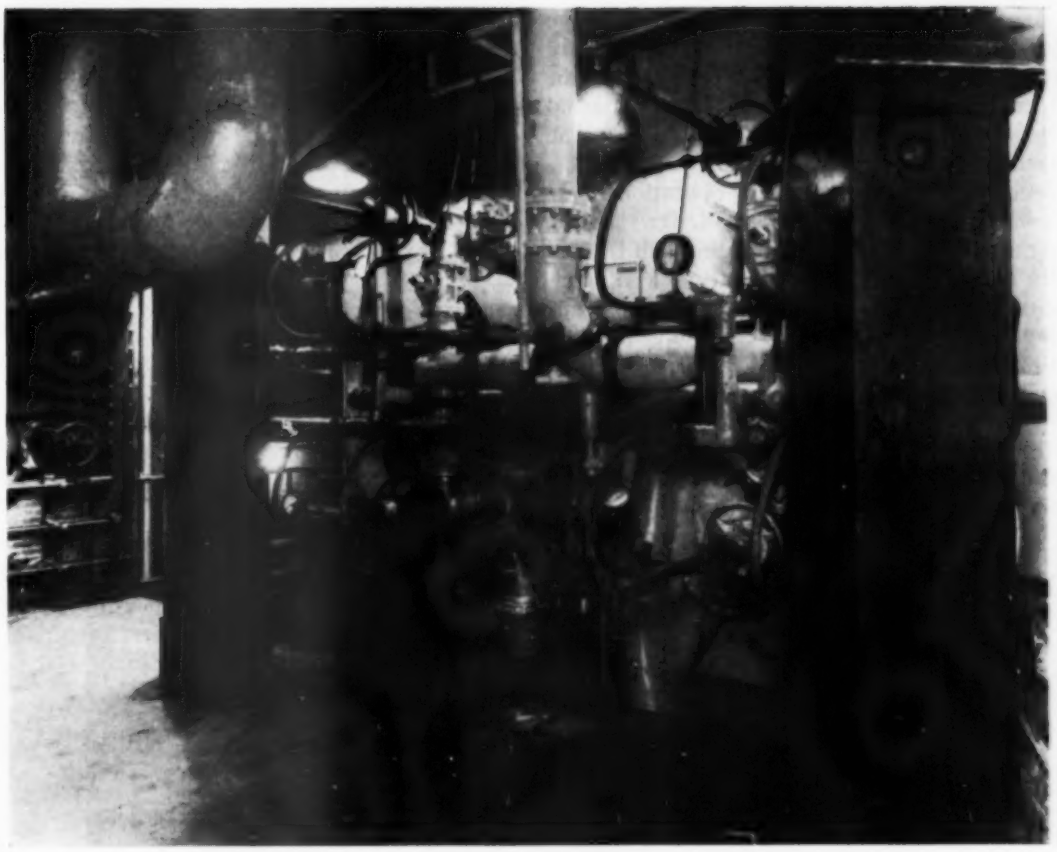
Three new 1500-kw back-pressure turbine-generators were installed in 1947, providing a dependable source of power and exhaust steam. A greater problem remained, however, that of replacing the boilers and auxiliaries. The boiler house constructed in 1911 originally housed two floors of 24 boilers. In 1926, it was revamped and four boilers remained, each being an ingenious combination of two of the original boilers placed over a new furnace. The plant operated successfully in this manner for many years, but by 1950 it was evident that old age had caught up with the boilers and necessitated reductions in operating pressure with attendant loss of power-generating capacity.

The steam demand peak was approximately 300,000 lb per hr and it was decided to install two new boilers each rated at 140,000 lb per hr with 150,000 lb per hr maximum capacity. It was further decided to retain two of the existing boilers to serve as a spare for one of the new units.

The question of steam conditions was next. Steam was generated at a pressure of 200 psig saturated and exhausted from the turbine-generators at 10 psig for refinery use, with the exception of a diminishing amount extracted at 60 psig from one older turbine which was



Boiler erection in cramped quarters required close study



The boilers are equipped to burn coal, gas and oil

retained at the time of modernizing the power house. The 1947 turbine-generators, although selected to operate at 200 psig saturated initially, were constructed capable of conversion to throttle conditions of 400 psig, 600 F total temperature. In recent years, however, refinery operations have been such that the new turbines could not be removed from service long enough to accomplish the conversion. They were capable, however, of operation at 250 psig 500 F total temperature without changes. With an eye to the future, it was decided to peg the new boilers at 400 psig, 600 F and install two pressure-reducing and desuperheating systems to deliver at 250 psig, 500 F and at 200 psig saturated, respectively. Ultimate plans call for conversion of the 1947 turbine-generators to 400 psig, 600 F operation, replacement of the extraction turbine and replacement of the two remaining 200-psig boilers with a third 400 psig, 600 F boiler, thus achieving a complete conversion to high-pressure operation.

Boiler Selection

With the basic decisions made, the actual design began. The first step was the selection of boilers. Steam demands in a sugar refinery are erratic, subject to sudden and substantial changes. Furthermore, it is necessary to produce a small amount of steam for heating and cleaning operations over week ends. Operating records showed week-end loads as low as 15,000 lb per hr. Hence, it was desirable to choose boilers capable of operating over a ten-to-one range and capable of quick response to load fluctuations. Combustion Engineering, Inc. VU-type boilers were selected, equipped with tubular-type air heaters. The boilers were designed for firing fuel oil and pulverized bituminous coal since both fuels are suited for the type of operation to be encountered and facilities for handling both fuels were available with minor modifications.

From the engineer's point of view, perhaps the most stringent design consideration was the correlation of construction with plant operation. Lack of open space on the refinery site as well as economy dictated that the new boilers be housed in the existing boiler-house structure. This meant that construction must be conducted in such a manner that each new piece of equipment would have to be installed and in operation before its existing counterpart could be removed to make way for more new equipment. At no time could there be a cessation of steam and, as of this writing, with the first new boiler in operation, there has been no interruption of service.

The one bay in the building that housed no boilers was the obvious location for the first new boiler. As stated earlier, the structure had been built for two floors of small boilers, thus resulting in a high building with narrow bays between columns. Since the building was there, the boilers had to be designed to fit. After several studies, it was seen that by utilizing every available foot in height, breadth and depth, 150,000 lb per hr capacity of boiler would fit but that forced- and induced-draft fans would not. As a result, the fans were relegated to platforms outside the building wall behind each boiler.

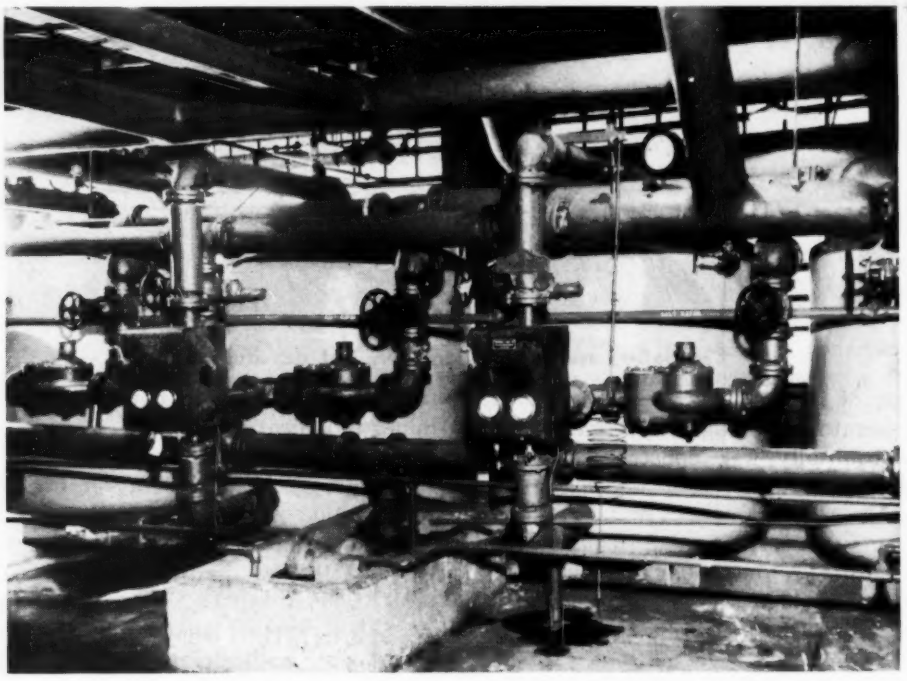
In keeping with current practice, the fans are exposed to the weather to save the cost of enclosures. The fans are of American Blower Corp. manufacture, the forced-draft fan being equipped with inlet vanes and the induced-draft fan with outlet dampers. Because of the wide load range and for reasons of economy, the induced-draft fans are driven through Electric Machinery magnetic couplings. Outlet dampers remain open

throughout the effective range of speed control and come into play only at reduced loads. Steam coil heaters are installed in the air-heater air inlet to protect the air heater, dust arrestor, and exit gas ductwork from internal corrosion when operating at very light load, and in the winter with outside forced-draft air supplied.

The problem of keeping the plant in operation made itself felt in more ways than in the boiler design; that is, the feedwater system presented a like problem. Feed to the boilers had consisted of about 50 per cent condensate returned from the refinery and 50 per cent Brooklyn city water, the latter first passing through various heat-exchangers in the refinery where it attained a temperature of about 200 F before reaching the boiler plant. Once in the boiler plant, the city water went to a deaerator fed by exhaust steam and thence to a storage tank where it mixed with returned condensate before being pumped to the boilers. Feedwater treatment was confined to the introduction of chemicals into the feed line.

The existing deaerator and storage tank were old and required replacement. In addition, it was deemed advisable to provide sodium zeolite water softeners in the feed system to bring down the hardness and reduce the amount of direct chemical treatment necessary, thus improving boiler-water conditions. Finally, new boiler-feed pumps were required because of the higher operating pressure. The difficulties of installing this new feed system without interruption of service can easily be appreciated, particularly when it is seen that some of the new equipment, notably the feed pumps, now sit in the exact position of their predecessors.

The softener installation is a battery of five Hungerford & Terry units, four of which readily handle full output while one is regenerated. Following the softeners is a Cochrane, vertical shell, tray-type deaerator mounted over a horizontal storage tank. Storage is liberal and sufficient for about 25 minutes operation at full load, which is important in view of the indirect and complicated path of the city water before reaching the deaerator. Low-pressure storage capacity is cheap insurance against a loss in production resulting from a boiler plant shutdown.



Water softeners constitute an important link in a 100-per cent makeup cycle

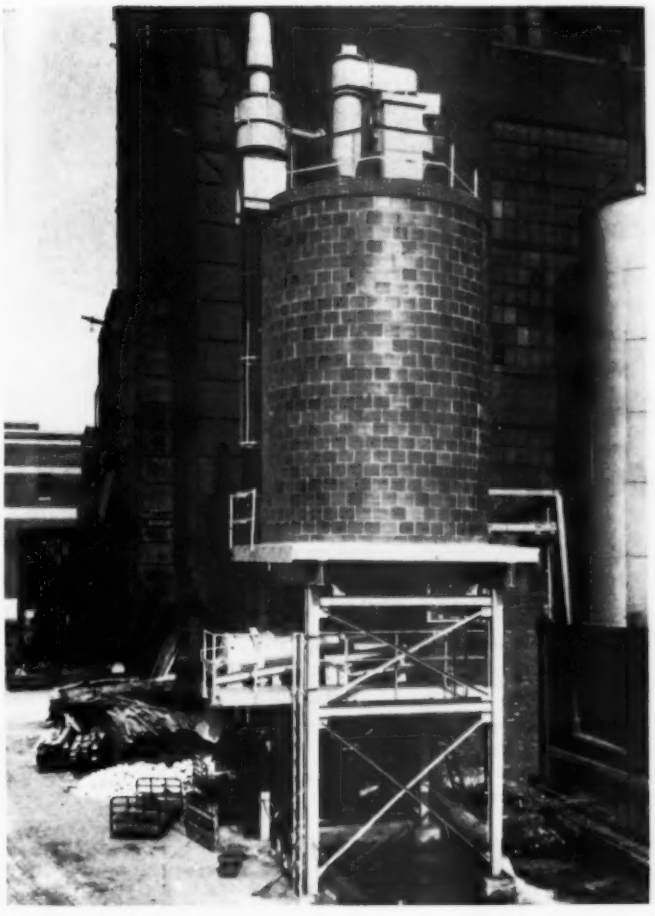
100 Per Cent Makeup Provided

It is not uncommon in a suger refinery for sugar to find its way into the boilers via condensate returning from process. This causes violent priming as well as deposits in the boiler tubes. The old boilers, having large diameter straight tubes, could be mechanically cleaned in such cases. This is not true, however, of a modern bent-tube boiler equipped with a superheater. Since the refinery contains many sources of possible sugar contamination, which could not be made foolproof without replacement of much equipment that was still serviceable, it was decided to convert the boiler plant to 100 per cent city water makeup. Through a series of piping modifications it was possible to recover the heat from condensate by using this in refinery operations and consequently operating economy did not suffer from dumping the condensate.

Two full capacity boiler-feed pumps are provided, one turbine- and one motor-driven. The pumps are of conventional horizontal split-casing design, manufactured by Warren Steam Pump Co. To provide for light week-end operation, a third pump was installed. This is motor-driven and has a capacity of one-seventh that of the main feed pumps. It was still necessary to get feedwater to the low-pressure boilers retained as spare capacity. A feedwater pressure-reducing valve accomplishes this satisfactorily.

Controls Installed

The question of controls received considerable attention. The problem was to provide a control system relatively simple in operation but still responsive to



A vacuum ash system replaces settling tank

rapid load fluctuations. In any industrial plant, the emphasis must be on reliability at the expense of refinements. Since the old boilers had no combustion control, and a direct-acting float operated the feed control, simplicity was doubly desirable. On the other hand, two main factors pointed to a more elaborate system; namely, fuel economy and smoke. The benefits of fuel economy are obvious and smoke is a vital concern in the New York Metropolitan area. A Fly Ash Arrestor Corp. mechanical dust collector is installed in the boiler outlet, but to make it effective close control of furnace conditions is necessary. The end result was a Bailey Meter system of steam-pressure control with fuel and forced-draft readjustment from steam flow-air flow ratio. Furnace pressure regulates the induced draft. In addition, a two-element drum-level and steam-flow control regulates the boiler feed.

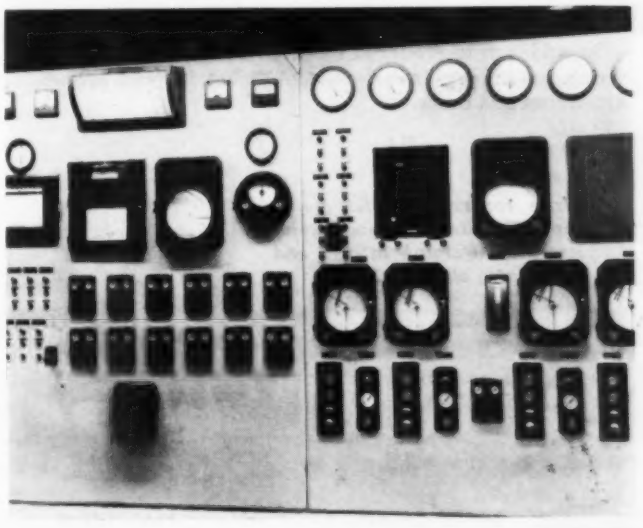
The pressure-reducing and desuperheating stations, considered to be auxiliary in most plants, are of prime importance in this installation. Until the complete conversion outlined in the beginning of this article is achieved, every pound of steam for power generation and process must be reduced and desuperheated. For this reason, the equipment is in duplicate providing 100 per cent spare capacity for each component of the system. The stations are of Republic manufacture with Taylor temperature control.

One of the least rewarding ways of spending money in a boiler plant is on ash disposal. A good system is necessary, however, and utlimately pays off in labor savings. In existence was a gravity sluicing system utilizing refinery waste water which, after passing under the boiler ash hoppers, went to a tank of several compartments with successively lower weirs. The water flowed over the last weir into the river and ash was removed from the tanks by clamshell bucket. It was impractical to adapt this same system to the new boilers because of lack of elevation between the ash hoppers and the settling tank. In addition, fly ash from a collector is hard to wet and would in all probability float over the weir into the East River. In consequence, a completely new National Conveyor vacuum ash system was installed. This system is powered by a steam jet and after several stages of separation followed by a water wash the ash discharges into a silo. Disposal from the silo is by a conventional type ash conditioner into trucks.

After design was complete and construction well along, the American Sugar Refining Company signed a contract with the Brooklyn Union Gas Company for interruptible natural gas service. Thus it became the first large industrial natural gas user in the area. Fortunately, the combination oil and coal burners furnished with the boiler were readily convertible to gas firing by the insertion of a gas barrel and the substitution of a longer oil gun. The combustion control system was modified by the addition of a gas flow-air flow controller for use when burning gas, and with the installation of some gas piping the plant went into operation equipped to burn three fuels, as economy or necessity might dictate.

A stranger visiting the boiler plant might find it lacking in beauty and might wonder at the arrangement but he could not fail to be impressed that everything fits, can be maintained, and most important of all it operates satisfactorily.

C. F. Huttlinger, vice president, of the American Sugar Refining Company was in overall charge of the project, assisted by F. R. Oates, of the Construction Department. George Krebs, Brooklyn Refinery plant engineer, coordinated construction with plant operation and D. C. Coles, of the Construction Department, served as superintendent of construction.



The control panels which are now in a temporary location will be moved to a central point when space is cleared by removal of the low-pressure boilers

Supercritical Pressure Power Plants

AT a meeting of the Metropolitan Section of the ASME on October 28, an audience of more than 800 engineers showed an intense interest in supercritical pressure steam power plants. Two phases of the subject were considered: the thermodynamic aspects of cycles that might be used and some basic considerations in designing turbines to operate in the range above critical pressure. Mr. R. C. Roe, president of Burns & Roe, Inc., was chairman of the meeting, which was the first of a series of two lectures. The second, scheduled for November 5, was to deal with some aspects of the design and selection of boilers and boiler feed pumps.

Thermodynamic Cycles

Professor Jerome Bartels of the Mechanical Engineering Department of the Polytechnic Institute of Brooklyn was the first speaker and concerned himself primarily with theoretical thermodynamic considerations of the supercritical pressure power plant. His presentation was in part based on studies carried out for the consulting engineering firm of Gibbs and Hill, Inc.

In advancing thermodynamic arguments Professor Bartels began with the simple Rankine cycle and showed the effect of increased pressure upon turbine heat rates. Comparing cycles with initial pressures of 700, 7000 and 70,000 psia, it was shown that the average temperature for adding energy (and consequently the cycle efficiency) was greatest for 7000 psia initial pressure, with a fixed 1200 F throttle temperature.

Next an analysis was made of a simple cycle using a turbine efficiency of 86 per cent. This was carried further by the addition of one stage of reheat and then a second stage of reheat. Incremental gains for the second stage of reheat were less than for the first stage. The analysis then proceeded to the effect of feedwater heating starting with a single stage.

In carrying out the steps in the thermodynamic analysis from the basic Rankine cycle to the cycle combining multiple reheat and several stages of feedwater heating, two design criteria were arrived at:

1. Extraction points should be at the crossover and avoid the top end of reheat turbines. If the extraction takes place just beyond the reheater, marked irreversibility is introduced.

2. It is desirable to have equal or nearly equal resultant increases in entropy across the heaters.

Professor Bartels analyzed a cycle involving eight stages of feedwater heating and two stages of reheat. Throttle steam conditions were 6800 psia, 1200 F with initial reheat to 1200 F taking place at 1111 psia and the second reheat to 1200 F taking place at 100 psia. Based on thermodynamic calculations alone, a net station heat rate of 8160 Btu per kwhr may be expected for this cycle.

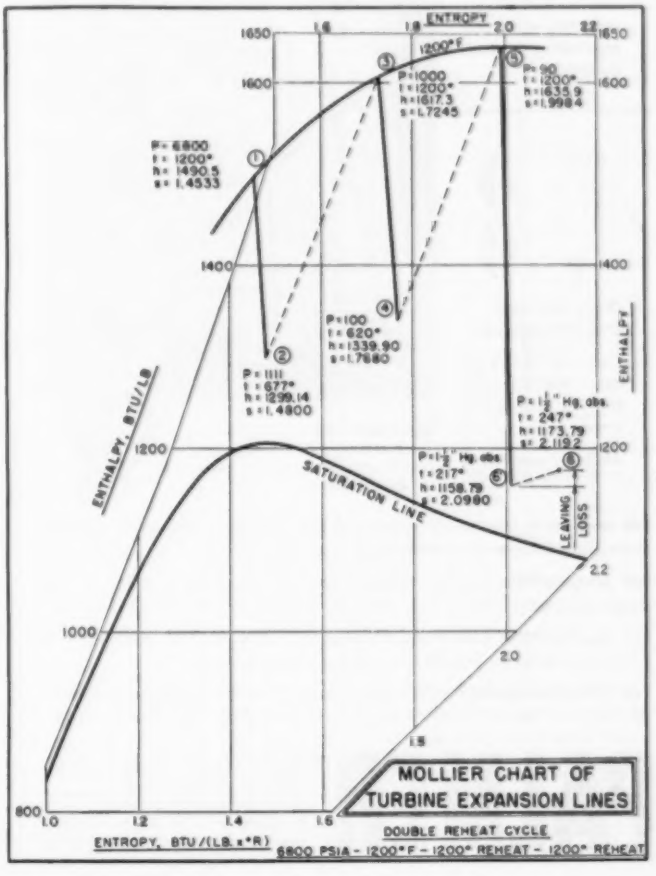
In the course of the discussion it became apparent that it would be necessary to readjust concepts of the nature of fluids in steam power cycles. At pressures greater than critical it is impossible to form bubbles or to boil the liquid. This physical condition can be reached in the feed pump, and beyond this point the substance will expand gradually as additional heat is added. It is believed that there is no theoretical limit to the temperature that can be reached.

Another need is to obtain additional experimental data upon which to base steam tables in the region beyond critical pressure. Thermodynamic analyses made by Professor Bartels were on the basis of extrapolation from the Keenan and Keyes steam tables. Certain cross-checks based on the expansion of steam in an ideal turbine were used to indicate the validity of the extrapolations.

Turbine Design Considerations

The second part of the program was a discussion of turbine design problems by C. D. Wilson, engineer in charge of steam turbine design for Allis-Chalmers Manufacturing Co., assisted by A. C. Holmes, supervisor of engineering calculations for the same company. Mr. Wilson limited his remarks to general turbine constructions and designs that might be used. He emphasized the necessity of thorough study of thermodynamic considerations before beginning turbine design. Two typical cycles were considered, one operating at critical pressure with a single stage of reheat and the other operating at 4500 psia, 1150 F with reheat to 1100 F and then to 1050 F.

Increase of pressure to the critical point and beyond makes it possible to take full advantages of gains resulting from two stages of reheat. For single stage reheat, the optimum pressure at the reheater is 16 to 20 per cent of the initial pressure. For two stages of reheating, the pressure of the first stage should be from 20 to 24 per



cent of the throttle pressure. In turn the pressure of the second stage should be 20 to 24 per cent of the first stage, or 5 to 6 per cent of the throttle pressure.

Only units of large capability can be economically justified for operation at or above the critical pressure. Because of the large investment involved and the complexity of controls required, it is believed that turbine unit size should be in the range of 150,000 kw or larger.

One type of turbine construction proposed for machines operating at or above the critical pressure is the barrel arrangement similar to that used for boiler feed pumps. This construction reduces the physical size of the turbine because of the elimination of horizontal bolted joints. Other advantages include more even heating and cooling because of the symmetrical shape, which permits a reduction in wall thickness and makes it possible to design more conservative stress levels. Mention was also made of the possibility of employing internal steam cooling with this type construction.

Another arrangement for power generation at supercritical pressures is to mount a number of small high-speed turbines on a common reduction gear connected to a 3600-rpm low-pressure turbine-generator. Use of several of these high-speed machines would eliminate the usual problem of overdesigning the governing stage to take care of partial load operation. These turbines can be built with a one-piece forging for a casing, and with the high-temperature components of the machine small in physical size.

Boiler Water Gage Illumination With Mercury Vapor Lamp

By EDGAR W. WALES* and
WILLIAM G. STEINMILLER†

IN the early days of the power industry, characterized by low pressure and low height boilers, tubular water glass gages were used to determine the level in the drum. Usually these water glasses could be read directly from the floor without illumination being necessary. However, in some cases a bare incandescent lamp was placed behind the tubular gage glass. Later as these low-pressure boilers increased in height a metallic shield, housing one or more lamps and covering the full length of the glass, was used to provide more positive lighting.

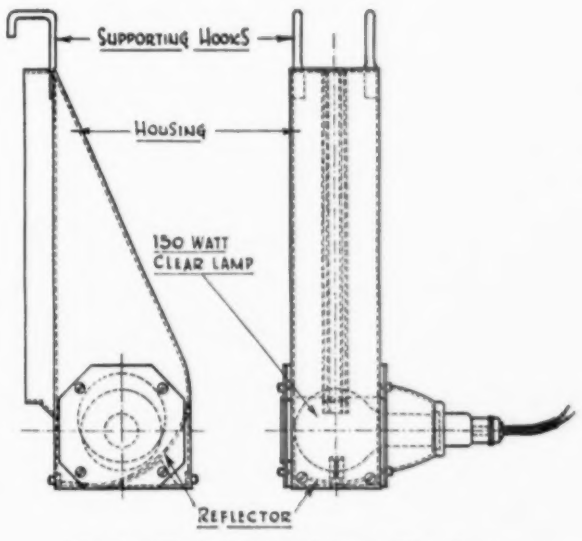
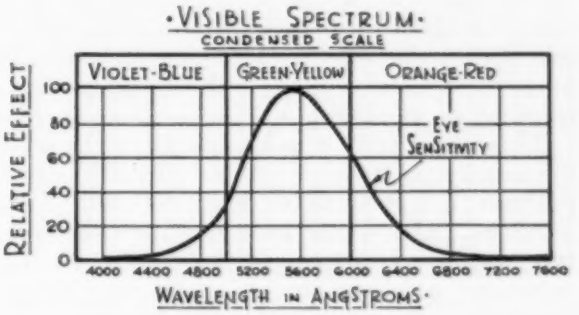


Fig. 1.—Typical incandescent illuminator

As the demand for steam power grew, the pressure and capacity as well as physical size of power boilers steadily increased. As a result, the tubular gage glass was supplanted by the newer flat glass gage which is more suitable for the higher steam pressures. One of the common types of illuminators used on flat glass gages is shown in Fig. 1. It consists of a sheet metal housing attached to the rear face of the gage. Illumination is provided by a 150-watt clear incandescent lamp located in the bottom of the housing and below the lowest point of gage visibility. The light is directed upward to the gage slot at the desired angle with the aid of a curved reflector located beneath the lamp. The water level appears as a bright spot with this type of illuminator when viewed from below the front of the gage. Other methods utilizing various optical phenomena together with incandescent lighting were also developed to differentiate between steam and water space in flat glass gages.

As the trend toward higher boilers continued, it became quite common to find the water gage 70 or more feet above operating level. These extreme heights plus interference by structural members make it impossible to view water gages directly on modern units. Therefore, gage images for large boilers are commonly transmitted to the operating level through a mirror system. As the total reflecting distance approached 100 ft, it became apparent that the incandescent source of illumination was not sufficient to produce a clear image for extended periods at the control level. One of the reasons for this shortcoming is that the visible radiation from incandescent lamps is primarily in the red portion of the spectrum where eye sensitivity is below its peak. Also, the predominant red lighting of these lamps is subjected to considerable absorption by rust and dirt deposits common to boiler gages. These factors, together with some natural loss of light in mirrors, impose a serious limitation on the distance through which a clear image can be transmitted without frequent servicing of gages to maintain clean glasses.

One answer to this growing problem is the use of mercury vapor lighting for gage illumination. This type of



·LAMP TYPE·	3800-5000A		5000-6000A		6000-7600A	
	LUMENS	% TOTAL LUMENS	LUMENS	% TOTAL LUMENS	LUMENS	% TOTAL LUMENS
A-H4 MERCURY 100W.	50	1.5	3230	98	25	.75
STD. FILAMENT 100W.	50	3.1	1170	72	400	24.50

Courtesy of G.E.

Fig. 2.—Eye sensitivity and approximate lamp performance

lighting has numerous advantages over ordinary incandescent filament lamps. First of all, the intensity of illumination of the basic mercury lamp is one and one-half times that of an incandescent lamp of the same wattage. Also, the mercury lamp is about twice as effi-

* Development engineer, Yarnall-Waring Co.
† Research engineer, Yarnall-Waring Co.

Fig. 3.—Four-glass gage and illuminator with mercury vapor lighting

cient and therefore produces approximately twice the amount of light as a comparable filament lamp. Furthermore, of the total visible light emitted, 98 per cent is in the green-yellow part of the spectrum where eye sensitivity is highest. In comparison to this, only 72 per cent of the visible light from the filament lamp is emitted in the most sensitive range. The foregoing facts are illustrated by the graph and curve shown in Fig. 2.

When the mercury lamp is applied to boiler water gage illumination, it is found that its extremely bright light produces a highly visible gage slot with a brilliant meniscus. Also, as the lamp is of the vapor-discharge type, meniscus visibility is further enhanced by the light pulsations which produce a stroboscopic effect, with agitation of the water surface by dripping condensate in the gage.

Fig. 3 shows a water-gage illuminator which was developed to utilize the advantages of mercury vapor lighting. Basically it consists of a 100-watt projector-type mercury lamp supported in a cast-aluminum holder which, in turn, is attached to the sheet metal housing. This entire unit hooks to the rear face of the gage. The lamp is so positioned in the housing as to give a good dispersion of light over the full length of the gage glass. The lamp is of the all-weather variety with sealed-in reflecting surfaces that do not deteriorate during its life. When the front face of the gage is viewed from below, the slot appears as a bright column of light with a slight greenish-yellow coloring. The water level is indicated by a brilliant white spot that generally shimmers because of agitation by dripping condensate.

Application of the mercury vapor illuminator to water gages has resulted in transmission of water levels over longer distances than previously attained by use of incandescent illuminators. From the standpoint of avoiding too frequent servicing of glasses, the limit on transmission distance for incandescent illuminators is of the order of 80 ft. In contrast to this there are numerous installations now using mercury vapor illuminators which have transmittal distances somewhat over 100 ft. There are also a number of other installations where clear images have been successfully transmitted up to 125 ft using mercury lighting in an open-mirror system. One of these long distance arrangements is shown in diagram by Fig. 4. Recent tests using a reflecting system of four open mirrors have proved that it is possible to transmit a clear image through 180 ft.

Another feature of mercury lighting which has shown up in actual practice is that clarity of the entire gage slot and meniscus can be maintained for longer periods of time. This follows because the green-yellow light from the illuminator is less affected by absorption from red oxide and other dirt deposits on gage glasses. Therefore, service life of flat glass gages has been increased where previously more frequent servicing of glasses was necessitated by these dirt and rust deposits.

More recently, the mercury vapor illuminator has been successfully applied to the transmission of gage glass images through wired industrial television. The greatest success has been with camera tubes whose spectral response approaches that of the human eye. The reasons for this are apparent from Fig. 2. Such a combination of lighting and camera tube has resulted in a clear image at the receiver with the water level showing as a very bright spot or star. Furthermore, detrimental effects from rust and dirt deposits are minimized.

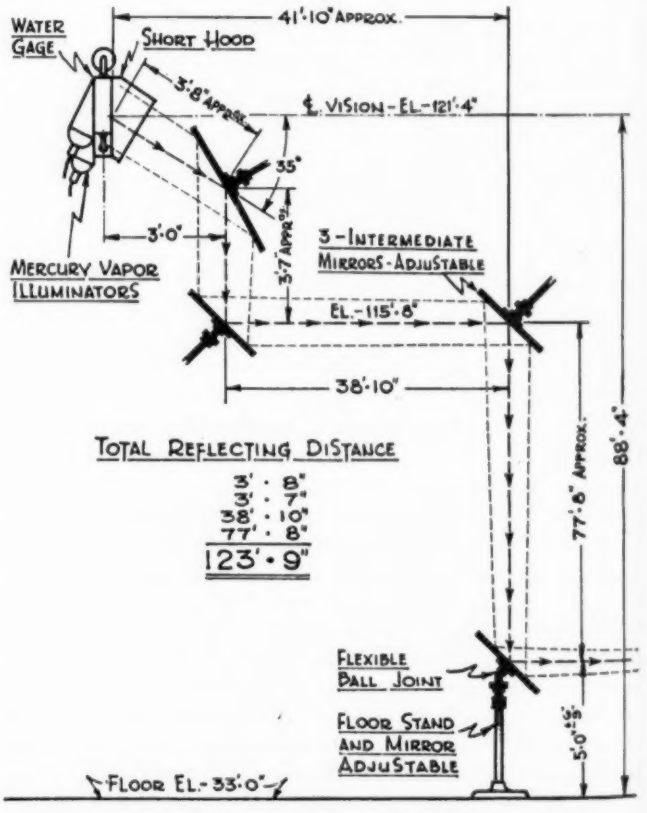


Fig. 4.—Long-distance water-gage reflecting system

Fourteenth Annual Water Conference

MORE than 550 chemists and engineers were present at the Fourteenth Annual Water Conference sponsored by the Engineers' Society of Western Pennsylvania and held at the Hotel William Penn, Pittsburgh, October 19–21.[1] This was the largest attendance ever recorded for this annual event. One of the outstanding features of the meeting was a panel discussion on "Corrosion and Deposits in Condensate and Feedwater Systems" in which nine participants presented papers on many aspects of these problems.

Use of Filter Aids

In a paper entitled "Filter Aid Filtration of Water," **G. R. Bell** of the Johns-Manville Research Center stated that filter aids were first applied in industrial work in sugar refineries more than 40 years ago. However, it was not until World War II that extensive development took place, in part due to the efforts of the British based upon their North African Campaigns. Diatomite filters weighing only a tenth of sand-filtration units were widely used to supply portable water to the American armed forces.

Filter aid filters can be safely operated over a range of one-half to more than 20 gal per sq ft per min. Although many have been led to believe that these filters are best adapted to high flow rates, this can require increased power consumption and results in very short cycles. With smaller flow rates, cycle length increases disproportionately, and there are decreased power and labor costs.

Mr. Bell reported on five installations at plants of his company. One at Jarratt, Va., filters Notaway River water for 300-psig boiler feedwater makeup. Enough suspended clay is removed so that sludging and caking in the boiler will not occur. Water in excess of 100 ppm turbidity is encountered several times a year and is being handled in this unit.

Refinery Water Treatment

A paper providing a history of water treatment of refineries of Esso Standard Oil Company and affiliates was prepared by **L. H. Zepfler** and **J. C. Hill.** Water treatment at these refineries is principally a problem of preparation of boiler feedwater. Prior to 1915 oil derived from reciprocating pumps was a principal source of trouble. Following World War I, conversion of boilers to oil firing paralleled by an increase in steam demand resulted in thick scale deposits which made boiler outages more frequent. At the Eagle Works in Jersey City, average boiler runs decreased to about two weeks, even at reduced load. After a period of four years, during which a number of schemes were tried without success, a zeolite plant was installed and provision was made to remove oil from condensate. The former eliminated problems due to scale and made possible a reduction of the boiler cleaning crew from twenty to one and an increase in the periods between cleaning from every four weeks to a yearly interval.

At the Bayway Refinery in Linden, N. J., water treatment was by means of a batch warm lime-soda plant from 1920 to 1952. Internal phosphate treatment was also provided. During World War II increased economizer deposits limited water flow to the boilers. This problem was solved by adding 8–10 ppm of a dispersive agent to the feedwater. A hot lime-sodium aluminate-zeolite plant was completed in 1952, the Sphericone tank used in the plant being the largest ever built. The improved feedwater quality from this installation has resulted in better boiler dependability.

At the Bayonne plant difficulty was experienced because of the presence of wax in the feedwater. This is expected to be solved by the installation of a high-capacity resin exchanger plant and additional filters.

The authors also discussed problems at other plants including a refinery at Aruba, Netherlands West Indies, for which water is imported from the United States for boiler feed. Before use this water is chlorinated, pressure filtered and zeolite softened.

Mixed Bed Deionization

Operating features of the mixed resin bed type of ion exchange process and limitations that have been encountered were the principal topics of a paper by **W. S. Morrison** of the Illinois Water Treatment Co. This process, now in its fifth year of industrial application, has found ready acceptance because of its capability of producing at rapid flow rates high resistance water which is almost totally free of dissolved solids, acids and bases.

Regeneration of mixed exchangers is the most important phase of operation. The anion and cation exchange resins have different densities, which enable their separation, following which they are introduced simultaneously, rinsed and then remixed. Separation of the high base anion exchange from the sulfuric cation is accomplished in about 15 minutes, using 100 per cent bed expansion. Water quality depends upon temperature, resins employed, chemical regeneration level and flow throughput. Commonly encountered water temperatures do not seriously affect the exchange rate, so that comparable deionized water quality is obtained from different supplies.

Turbidity of the influent water is an important point for both multi-bed and mixed-bed installations and should not be in excess of 5 ppm, APHA Standards. It is well to maintain water turbidities as low as economically possible, especially for mixed-bed deionization.

Mr. Morrison expressed the opinion that the complexity of the silica ion is such that it responds to ion exchange with almost complete removal of the ion only if cation leakage is held to an absolute minimum. Because mixed-bed deionization gives almost zero cation slippage, complete silica removal is possible. Examples were provided from two power plants, one located in the south employing mixed-bed exchange and the other in

[1] Copies of the proceedings, including complete papers and discussions, may be obtained for $7.50 by writing the Society office at the same hotel.

the midwest using a cation-degasification-anion system. Silica leakage in the latter was ten times that shown in mixed-bed operation.

Difficulties are sometimes encountered in maintaining high-quality effluent from waters low in color and turbidity. Studies have disclosed that organic materials may be responsible for the gradual decrease in resistivity of the treated water. It is believed that the resins adsorb these organics, binding them irreversibly so that operating cycles are shortened. Both mixed-bed and multiple-bed systems are ultimately affected by organics in influent water. However, there seems to be a difference between the action of organics derived from natural causes, which can readily be removed from the resins by chlorination, and unnatural organics (such as acrylic acid), which have been dumped into streams. Studies are being continued to find effective ways to remove these unnatural organic compounds.

Metallographic Studies

Five categories of metal failures encountered in the water treatment industry were discussed in a paper by **E. G. Johnston** and **A. O. Walker** of the National Aluminate Corp. They showed how metallographic examinations could be used in connection with overheating, cracking, corrosive attack, external tube attack and failure of copper alloys.

Probably the most common single cause of boiler metal failure is overheating. Metallographic studies may be useful in detecting spheroidization, distorted microstructure, decarburization and grain growth and intergranular oxidation.

Cracking may take place in cases where excessive temperatures do not occur. Caustic cracking is continuous, predominantly intergranular and originates at the surface of the metal. Fatigue cracking, which involves repeated stresses in excess of the endurance limit, seldom occurs in boiler tubes, although severe cases have been observed in superheater tubes. Caustic corrosion and brittle tube attack have been found in a few high-pressure boilers. Attack takes place under iron oxide deposits, where boiler water solids may concentrate. This type of boiler water concentrate may also act on internal tube surfaces to form atomic hydrogen.

In connection with corrosive attack the authors mentioned three selected cases involving corrosion in partly dry boiler tubes, in steam circulating tubes and resulting from an applied electric current.

External tube attack was discussed in terms of soot-blower impingement, entrained fly ash, and difficulties resulting from formation of alkali metal sulfates and dropping of flue gas temperatures below the dew point. Failures resulting from the latter two readily lend themselves to metallographic studies.

With regard to copper alloy failures, metallographic examination is helpful in the case of dezincification which is favored by the presence of the beta phase of brass.

Discussion

F. L. LaQue of the International Nickel Co. emphasized that results of metallographic examination should be combined with analyses of the metal and corrosion products. Also, the history of the material and the conditions under which it was used must be taken into consideration. Without such supplementary data metallographic examinations may be misleading and lead to misinterpretation.

Panel Discussion on Corrosion Deposits in Condensate and Feedwater Systems

The first speaker was **S. K. Adkins** of the National Aluminate Corp. whose topic was "Factors Influencing Metal Loss in Condensate and Feedwater Systems." There are three categories of metal loss: corrosion, erosion or corrosion-erosion.

It is generally accepted that erosion is a hydraulic physical problem and must be corrected by mechanical design. Corrosion-erosion is most commonly encountered in systems handling high-pressure, high-temperature condensates. Corrective measures include neutralization of the condensate and improvement of flow characteristics.

Five gases are considered the most important factors contributing to the corrosive nature of condensate or feedwater. These are oxygen, carbon dioxide, ammonia, sulfur dioxide and hydrogen sulfide. In addition, according to Mr. Adkins, the pH is probably a very large factor in causing corrosion, and the gases might be considered subfactors that affect the pH. Studies have shown that very pure water free of dissolved gases and acidic components is quite capable of dissolving iron. This emphasizes the necessity for correction of pH even though there are no dissolved gases present.

"Iron and Copper Deposits in Boilers" was the topic of a discussion by **R. C. Ulmer** of Combustion Engineering, Inc., who was concerned mainly with the problems of high-pressure boilers in central stations. Analyses of deposits in these boilers indicate the chief constituents to be the iron oxides, hydroxy-apatite, magnesium complexes, sodium-iron and sodium-aluminum complexes and copper. The boiler and preboiler sections are the source of iron, while copper comes from the preboiler section. Deposits of iron and copper cause serious operating problems as these materials settle out as slightly adherent coatings of finely divided material on heat transfer surfaces or as a mixture of coarse and fine deposits in areas of less rapid circulation. Metal overheating may result in cases where adherent scale is formed.

Dr. Ulmer mentioned the use of controlled circulation in boiler design, using as an example a unit operating at 2650 psi and employing $1^1/_2$-in. tubes throughout. Comparing this with a natural circulation unit using 3-in. tubes, he showed that the velocity is much greater in the case of the smaller tubes, while the skin temperatures are considerably lower. Under these conditions there is much less tendency for film boiling or steam blanketing to occur.

The third discussion was by **T. W. Bigger** of the General Electric Co. whose topic was "Corrosion in the Moisture Region of Large Steam Turbines." For many years corrosion damage to turbines was corrected by building up corroded areas by means of fusion welding of corrosion resistant materials, or by means of patches or steel strips of these materials, mechanically attached.

This practice is still necessary in some installations. Comparison tests of actual and possible turbine materials are being carried out in the hope of reducing damage due to corrosion.

The nature of the problem can be better appreciated when it is understood that over half a ton of water per minute will leave the last stage of a 60,000-kw condensing turbine despite the use of stage drains. Evidence of wet region corrosion is in the form of anodic areas in nonchromium bearing metals, surrounded by large areas covered by a hard layer of products of corrosion. When a condensing turbine subject to such corrosion is first opened after a period of operation, bright metal is seen in the anodic areas and the crystal structure is often evident to the naked eye. Since the damage is not seen until a period of several months or even years of operation, and there is a heavy flow of corrosive liquid over the metal, erosion contributes to the action. The usual localized anode-cathode appearance which follows galvanic action is replaced by the erosion-enlarged anodic areas and the large deposit-coated areas.

"Effect of Sulfite Treatment of Boiler Water on Condensate pH" was the topic of a discussion by **F. L. Archibald** of Boston Edison Co. He pointed out the importance of the location of the sampling point for pH determination, noting that the usual points at the hot well or at the boiler feed pump suction may give a false sense of pH protection. Through the process of sampling condensate in the early moisture regions of the turbines (removing the samples from contact with the steam before cooling), pH values were found which definitely showed that the water in this region was aggressive from the pH viewpoint, even with ammonia feed maintaining values of 8.8 to 9.0 in the hot well and boiler feed pump suction. It was further demonstrated that low pH value in the early moisture stages prevailed whether or not ammonia was being fed to the cycle.

By using a sensitive modification of the test for sulfite in boiler water, it was demonstrated that the internal turbine condensate has a reducing property, acid in nature, which varied directly with the concentration of sodium sulfite in the boiler water. Due to the acid nature of the material the pH also varied directly with concentration of sodium sulfite in the boiling water.

The next speaker was **Prof. F. G. Straub** of the University of Illinois, whose topic was "Comparison of the Action of Ammonia, Amines and Hydrazine in Reducing Metal Pick Up." The solubility of iron in pure oxygen-free water decreases as the pH increases, and both laboratory and plant data indicate that iron solubility approaches zero when pH is in the range of 9.0–9.2. To reach this condition, an alkaline type chemical must be present which will be in a vapor form in the steam but which will have low volatility in the temperature range encountered in this zone of the turbine. The relative volatility may be expressed as a distribution ratio between the amount of material in the steam in equilibrium with the amount present in the water at a given temperature.

Ammonia in this temperature range has a distribution ratio around 7 to 10. Pure water would require about 0.2 ppm of ammonia to have a pH around 9. Thus if ammonia were present in the steam so as to have 0.2 ppm in the initial moisture forming it would be necessary to have from 7 to 10 times as much in the steam or 1.4 to 2.0 ppm. The amount of ammonia maintained to keep a pH of 9 in the feedwater or main condensate is between 0.2 and 0.5 ppm. It would almost be impossible to keep values of 1.4 to 2.0 ppm in the system without having excessive ammonia concentrations in the air removal evacuator drains or deaerator vents.

Cyclohexylamine has a distribution ratio around 2 to 4. About 2 ppm of cyclohexylamine is required in water to maintain a pH of 9. If it were desired to use this material to raise the pH of the initial moisture coming from the steam to a value around 9 it would be necessary to have about 4 to 8 ppm present in the steam. Unless excessive concentrations and pH values well above 9 are carried in the main condensate, the cyclohexylamine would not impart sufficient pH to the initial moisture to give good protection.

Morpholine has a distribution ratio of 0.4 and requires about 4 ppm to give a pH of 9 to pure water. Thus with 4 ppm in the main steam cycle the water in the feed cycle would have a pH of 9. The initial moisture forming would have 10 ppm of morpholine and a pH value around 9.1 to 9.2. This concentration of the morpholine in the initial moisture brings the higher pH in the area where it is desired and also allows an excess of the alkaline material to be present to neutralize any acid-forming material like sulfur dioxide.

Hydrazine has been suggested as a chemical to perform similar functions. It is a very strong reducing agent, only slightly volatile in dilute solution and a weaker base than ammonia. It is possible to use hydrazine by continuous feed to the deaerated water so as to have a small excess present for the feedwater at all times, thus keeping the feedwater reducing in nature and preventing higher oxides and oxygen from entering the boiler. The small amount of ammonia formed would keep the pH of the feedwater in a higher range. This treatment allows no reserve in the higher pressure boiler to react with oxides or oxygen which might enter the cycle at times of load changes. Continual testing would be required to be certain that the required excess of hydrazine is present in the evaporator at all times.

The sixth speaker was **J. D. Ristroph** of the Virginia Electric and Power Co. who told of power plant experience in a paper entitled "Cyclohexylamine for pH Control of Condensate and Feedwater." The initial use of this chemical was at the Bremo Station in 1951 where difficulty had been encountered due to deposition of iron oxide on the impellers and casings of the boiler feed pumps. With the addition of the amine, pH of the system was raised from 6.4 to 8.5. The effect of its addition on the corrosion rate was evident by a reduction of iron content from an average of 0.22 ppm prior to usage to 0.07 ppm following six weeks of controlled pH. In addition to the overall reduction in corrosion products pickup throughout the cycle was reduced, as was copper contamination in the condensate.

The usage of cyclohexylamine on the 1550-psig controlled circulation unit at Chesterfield Station was initiated during preliminary operation of the new unit in 1952. The amine is fed continuously to the outlet of the 14th-stage deaerating heater, and the cycle pH is controlled at 8.7 to 8.8. Sodium sulfite is fed continu-

ously at the hot well of the condenser in sufficient quantities to maintain 1–3 ppm residual sulfite in boiler water. After several months of operation the boiler was opened for internal inspection. Interior surfaces were found to be very clean except for a film of loose deposit (predominantly black iron oxide) on the drum surfaces. Tube surfaces were clean, with traces of deposit on the orifices. The boiler drum and internals were vacuum-cleaned and approximately five pounds of deposit was collected which was considered very low for a new boiler and feedwater piping system. Mr. Ristroph offered the following conclusions:

1. The use of cyclohexylamine to control pH in a feedwater cycle will definitely reduce corrosive action in the cycle.
2. In the same pH region, ammonia and amine give equal protection in the cycle.
3. The amine should be fed at a continuous rate since this provides uniformity and reduces the possibility of momentary overtreatment resulting in possible breakdown.

"Experience with Ammonia and Cyclohexylamine at the Springdale and Mitchell Power Stations" was the subject of a paper by **E. L. Jacobs** and **W. L. Thompson** of the West Penn Power Co. A study was made at Springdale in April 1951 with an inspection of a boiler feed pump impeller. This disclosed unusual heavy deposits of black iron oxide and brought out the fact that ammonia originating from the sewage and mine drainage in the Allegheny River was being admitted to the system with evaporated makeup. The quantities of ammonia vary inversely with the river flow. Cyclohexylamine treatment was also started in April 1951, the treatment being added with the regular boiler conditioning chemicals. In May 1952 ammonium chloride was substituted for cyclohexylamine to maintain pH control.

In reviewing the results of pH control over a $2^1/_2$-year period at Springdale, it is believed that this type of treatment has accomplished the immediate purpose of drastically reducing black iron oxide formation in the system. The involuntary treatment received by way of ammonia entering the system with the makeup and treatment using ammonium chloride as a control chemical produced less satisfactory results than did pH control with cyclohexylamine. Comparisons of the two control chemicals brought out that the use of ammonium chloride resulted in larger quantities of free ammonia, more difficult control and generally less satisfactory results than were experienced with cyclohexylamine. It is also believed that the latter afforded protection farther back in the system than is obtainable either with ammonium chloride or free ammonia.

Edward A. Yorkgitis of Hall Laboratories had as his topic "Precautions in the Use of Ammonia and Amines." Probably the first precaution is to avoid treatment which will increase attack on copper and its alloys. Ammonia treatment requires particularly careful attention at all times; it is necessary to have effective oxygen removal as well as careful pH control to avoid attack on copper.

Decomposition of amines may be undesirable because neutralizing amines produce ammonia, which may be harmful, while filming amines no longer provide the protection of filming action. When treating with cyclohexylamine or morpholine a check on ammonia concentrations is sufficient to detect decomposition. Hydrazine has been proposed as an oxygen scavenger and has been tried at some plants.

Pure cyclohexylamine and morpholine are flammable and are strong alkalies. To guard against fire, storage should be where there is at least ordinary circulation of air in a cool section of the plant.

The last paper in the series was presented by **R. F. Andres** of the Dayton Power and Light Company on the subject of "Analytical Methods for pH, Iron and Copper." For determining pH values of high purity condensate consideration should be given to frequent acid cleaning of the glass electrodes followed by prolonged rinsing in the water being tested, in order to minimize erroneous pH values.

Accurate determinations of trace quantities of iron and copper in condensate samples is not quite so simple. General practice in the past has been to concentrate on metallic constituents from relatively large volumes of condensate, followed by colorimetric chemical analyses of the concentrated solution. A new colorimetric method was proposed using extraction techniques to avoid the problems and disadvantages of concentration. The batho-phenanthroline method was adopted for iron in water and the carbamate extraction method for copper in water.

Some precautions that apply to these methods include the necessity for analyzing condensate samples as soon as possible following extraction in order to avoid the tendency for iron and copper to plate out on glass and plastic surfaces. Glassware must be thoroughly clean, and the only way to be certain of this condition is to run blank determinations with iron-copper free water in the glassware, going through the complete procedure until a constant reagent blank is obtained.

Testing Steam Purity in Small Plants

Three chemists from the Illinois State Water Survey, **R. W. Lane, T. E. Larson** and **J. W. Pankey,** prepared a paper entitled "Steam Purity Observations at Institutional Power Plants." It was desired to study ways in which steam purity may be improved, with the following objectives:

1. Obtaining information on water treatment factors involved so that more efficient and economical treatment may be designed.
2. Obtaining information on pertinent boiler design factors with a view to inclusion in future specifications.
3. Evaluating factors affecting blowdown limits, including establishment of those which are economical and safe.
4. Instructing plant personnel in proper testing, treatment and blowdown control.

The steam testing program has been going on for two years. Steam nozzles were installed according to the ASME Power Test code. To measure conductivity a strip-chart recorder was installed in conjunction with a modified Straub degasifier operating at a temperature of 210 F. However, in some plants ammonia was present in considerable variable amounts, and the use of correction factors for ammonia was found to be tedious and inexact. It was then decided to incorporate an ion

exchanger operating on the hydrogen cycle into the steam testing system, so that ammonia could be reduced to a value of 0.1 ppm or less. With variations in conductivity resulting from gas contaminants reduced to a minimum, the authors believed that increases in conductivity were definitely indicative of boiler water carryover.

Studies using this equipment were carried out on eight boilers in six institutional power plants. In all cases deaerating heaters supply feedwater to stoker-fired water-tube boilers operating at pressures between 125 and 150 psig. All boilers are equipped with continuous blowdown, and most of the plants have external water softening, either by sodium exchange or hot process lime soda.

Those plants equipped with four-drum boilers were found to have higher steam purity than those having three-drum boilers, largely because the former had greater space for steam release and steam storage. The studies also indicated the importance of proper internal baffling, especially in three-drum boilers.

Discussion

J. J. Maguire of W. H. & L. D. Betz pointed out that the ion exchanger employed by the authors increases the sensitivity of conductivity measurement because of the conversion of sodium sulfate, sodium chloride and sodium phosphate to their respective acids. It also eliminates ammonia prior to measurement, which enables detection of increases in solids with increase in boiler rating. It has the disadvantage in plants with a high ratio of alkalinity to other boiler water solids that measurement sensitivity may be decreased. Mr. Maguire reported that his organization has under development a small laboratory-type demineralizer operating on a continuous condensed steam sample which is intended to indicate the total impurity content of steam over an extended period of time.

P. B. Place of Combustion Engineering, Inc., noted that the application of ion-exchange equipment to testing steam purity is a step toward eliminating variations in conductivity that have no relation to carryover. However, it is not always necessary to degas steam samples in order to reach a satisfactory conclusion on steam purity. Since carryover from a boiler is a liquid entrainment of boiler water, the conductivity of the outlet steam should vary with changes in boiler water concentration. In most cases, the steam sample conductivity remains constant which is evidence that most, if not all, of the conductivity measurement is an indication of contamination other than boiler water, whether the sample is degassed or not.

Chemical Cleaning Advances

P. H. Cardwell of Dowell Incorporated presented information on various chemical cleaning research projects and told of some developments that may be expected in this field. Although hydrochloric acid is the principal solvent currently used for chemical cleaning, new materials and techniques are rapidly replacing it for some applications. Attempts are being made to develop new scale removal chemicals which will eliminate the use of mineral acids altogether. Realization of such developments would solve many current problems including acid corrosion, disposal of spent solvents and the problem of after-rusting following treatment.

There are many deposits found in steam generating units and other industrial equipment in which the scale consists of small grains held together by means of some type of binding material. These small grains usually possess electrical charge, and it is thought possible by means of colloidal solutions made up of particles of opposite charge to disperse and remove scale without using acid solvents. Considerable progress has been made in the use of thickened solvents which are paste-like materials. These can be made by the use of gellifying agents and their stability can be controlled over a wide range of time and temperature. They have found their most effective use in cleaning large volume units.

Another approach to deposit removal is the use of chemical dissolving action in conjunction with the application of mechanical force. High-pressure jets are used, the solvents being applied through specially designed nozzles operating at 2000 to 4000 psig.

Evaluation of Gadgets

In a paper entitled "Gadgets: Their Practical Performance in Water Conditioning" **B. Q. Welder** and **Everett P. Partridge** of Hall Laboratories defined gadgets as special devices requiring substantially no technical control which are alleged to treat water by non-chemical means to prevent scale, corrosion and other troubles encountered in the industrial use of water. They noted that current promotion of gadgets is at a periodic peak.

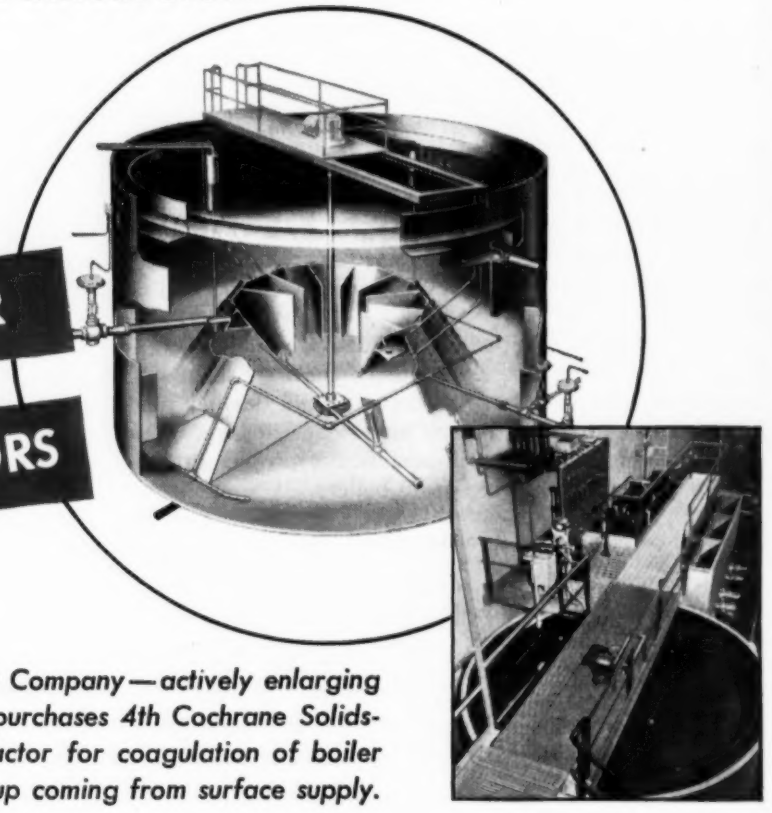
The paper was presented in the form of histories based upon observations of field engineers. Although technical literature contains some claims of beneficial effect and possible explanations, the case histories cited all end with the discard of the gadget. Two gadgets of the type involving an external electrical circuit were the subject of case studies, while five were considered in the category of those not involving electrical circuits.

Gadget promotion is likely to comprise several elements from the following list:

1. It is claimed that the gadget solves any and all problems encountered in the use of water: scale, corrosion, slime, taste, odor.
2. The gadget is alleged to produce many beneficial side effects.
3. The gadget is stated to achieve its remarkable results because of the alleged action in peculiar ways of natural forces, all described in language which sounds scientific but cannot be understood.
4. The gadget requires little or no attention and no chemicals are required.
5. The gadget is represented to be so effective that the initial cost will be refunded if it does not prove satisfactory within 60 to 90 days.
6. Testimonial letters, stated to be unsolicited, are offered to prove excellent performance.
7. Tests under controlled conditions in the laboratory are generally deprecated as not being capable of showing the performance in practice.
8. Advertising or promotion by mail is avoided or is much more conservative in tone than that supplied by direct contact.

COCHRANE WATER CONDITIONING
STARTS WHERE NATURE STOPS

REPEAT ORDERS FOR COCHRANE REACTORS



Duke Power Company—actively enlarging capacity—purchases 4th Cochrane Solids-Contact Reactor for coagulation of boiler feed make-up coming from surface supply.

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They can be built in small sizes—such as for the bottling trade, or in very large sizes—such as for paper mills, up to 110′0″ dia., capable of handling more than 20,000,000 GPD in a single unit.

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Sulfur in Fuels and Dewpoint of Flue Gases*

By DR. ING. W. GUMZ

Essen, Germany

THE harmful effect of sulfur on the dewpoint of flue gases is well known to power plant engineers. Yet the development toward lower gas exit temperatures, the increased use of high-sulfur fuels, coals as well as fuel oils, and the well-known effect of ash constituents on corrosion and fireside deposit formation requires re-examination. Much work has been done in experimental techniques, and more light has been thrown upon the process of SO_3 formation under the conditions of actual boiler operation, as indicated in the bibliography.

In order to know the conditions under which SO_3 is formed, is converted into H_2SO_4, and is finally condensed on heating surface, it is quite helpful to consider the thermodynamics of this overall process. Unfortunately, however, it is not possible to derive a correct value of the flue-gas dewpoint by calculation mainly because of the physical conditions of the reactions involved which are characterized by the only trace-like appearance of SO_3 and the inhomogeneousness of the gas mixture. The results of thermodynamic calculations, therefore, may be considered, first of all, as the limiting values obtained under the conditions of full equilibria and ideal mixing.

Fig. 1 shows SO_3 formation as a function of temperature (in Centigrade) and excess oxygen according to the reaction

$$2SO_2 + O_2 = 2SO_3$$

Equilibrium constants used are those by Bodenstein and Pohl. It can readily be seen that, for a given SO_2 content, the partial pressure of SO_3 will increase with decrease of temperature and increase of excess oxygen.

With a given amount of sulfur in the fuel, combustion with increasing excess air factors will lower the SO_2 content but increase the SO_3 formation, thus resulting in a maximum just around the amount of excess air usually employed in stoker furnaces. This behavior, as shown in Fig. 2, is another illustration of the well-known fact that stoker-fired boilers are liable to higher SO_3 contents in the flue gas, and, consequently, higher dewpoints than are pulverized-coal-fired boilers.

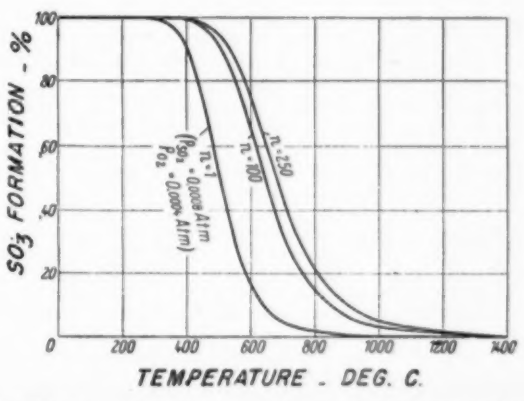

Fig. 1—SO_3 formation as a function of temperature and excess oxygen

Another effect which renders calculation quite difficult is the catalysis by certain ash constituents, mainly oxides, such as Fe_2O_3, V_2O_5 (in oil ash), and others, and the reverse effect of inhibition as influenced by other constituents such as Fe_3O_4, and of adsorption as by soot, silica smoke (SiO), and finely divided fly ash in general. The use of finely ground dolomite as suggested by McIlroy and co-workers and the use of auxiliary pulverized-coal firing in stoker furnaces belong into this category. Physico-chemical effects such as adsorption and increase of temperatures and equalization of the flue gas mixture contribute together to the decrease of free SO_3 content and of the dewpoint in supplementary pulverized-coal firing.

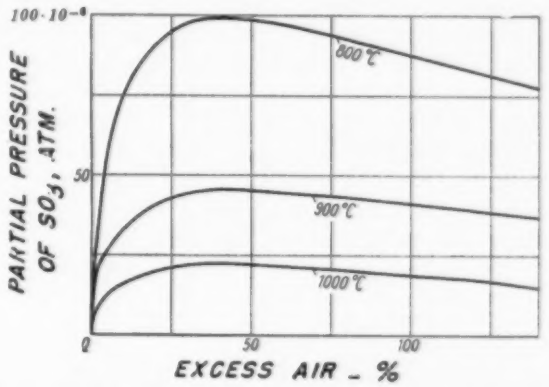

Fig. 2—Partial pressure of SO_3, in flue gases at temperatures of 800–1100 C as a function of excess air

The formation of sulfuric acid from sulfur trioxide and water vapor, which is always present in considerable excess, is shown in Fig. 3, based on equilibrium data by Bodenstein and Katayama. Under these conditions practically all SO_3 is converted to H_2SO_4 below 200 C (392 F). However, in actual operation they may not be exactly duplicated because of the extreme dilution of the SO_3 in flue gas and the inhomogeneity of its constituents, causing imperfect distribution of trace substances.

In spite of the extremely low partial pressure of H_2SO_4 in flue gases, its effect on flue-gas dewpoints is considerable. The reason is found in the steep increase of the

* Especially prepared for COMBUSTION by the author and based on his recent discussion in Brennstoff-Wärme-Kraft, Vol. 5, No. 8, pp. 264–269, 1953. Dr. Gumz was formerly consultant with Battelle Memorial Institute, Columbus, Ohio, and an occasional contributor to COMBUSTION.—EDITOR

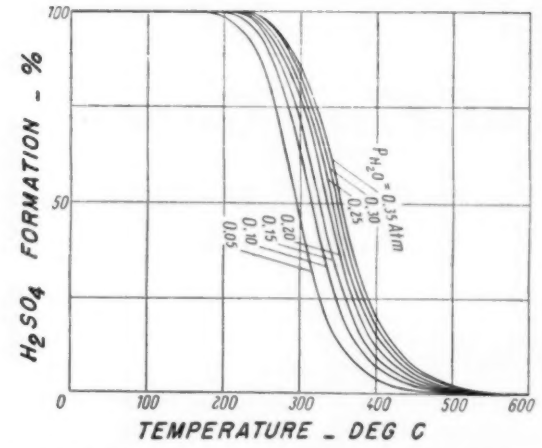

Fig. 3—H_2SO_4 formation as a function of temperature and partial pressure of water vapor

vapor line of the binary system H_2O-H_2SO_4, a fact which makes dewpoint metering a particularly delicate problem. The results of such measurements, therefore, differ widely. The data recently published by Francis have been used to draw the chart shown in Fig. 4.

According to these curves a very high dewpoint should be expected even with a moderate sulfur content as shown in the logarithmic scale of the abscissa. Practical observations, however, make it more likely that sulfur shows little effect up to a certain threshhold—possibly to be assumed as 0.9–1.0 per cent with fuel oil, and 1.5–2 per cent with coal. Beyond these limits the dewpoint will shoot up to an order of magnitude of 110–140 C (230–284 F). British investigators, such as Corbett and Fereday, and Flint, Lindsay and Littlejohn, have corroborated by their measurement that sulfur content, and even V_2O_5 content of the oil ash, had little influence, whereas other conditions such as burner design, furnace temperature and quality of mixing were of much greater effect.

Furnace and boiler designers have to take the consequences of this situation. The limiting factor is the lowest surface temperature at any boiler rating and special precaution is required to secure freedom from clogging and corrosion trouble. High sulfur fuels, however, do not necessarily mean a high gas exit temperature and low boiler efficiency. Choice of air heater system and the arrangement of heating surfaces—the last part preferentially in parallel-flow heat exchange—enable an economic solution as shown by Karlsson and Hammond and in the subsequent discussion of their paper. Boiler design has to be adapted to the fuel; the reverse adaption of the fuel to the boiler is not practical in most cases.

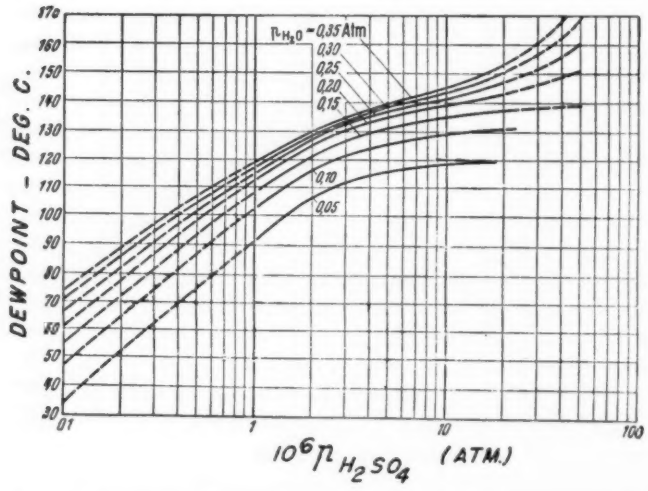

Fig. 4—Dewpoint of flue gases based on the measurements by Francis as a function of partial pressures of sulfuric acid and water vapor

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Power and Allied Subjects on ASME Annual Meeting Program

THE 1953 Annual Meeting of the American Society of Mechanical Engineers will be held in New York November 29 through December 4 with headquarters, as usual, at the Hotel Statler, and some sessions at the McAlpin and the Governor Clinton. There will be well over a hundred sessions involving more than three hundred technical papers, together with special lectures, and luncheon addresses. At this writing, the tentative program does not include authors of some papers listed. Among those of special interest to power engineers are the following:

Monday, November 30, 9:30 a.m.

"Thermal Conductivity of Gases," by F. G. Keyes, Massachusetts Inst. of Technology.

"Thermal Conductivity of Some Industrial Liquids," by H. L. Mason, U. S. Bureau of Standards.

"An Accurate Method of Determination of Thermal Conductivity of Insulating Solids."

"Thermal Conductivity of Fluids."

"Thermal Conductivity of Some Organic Liquids."

"The Kaplan Turbine—Design and Trends," by J. Fisch, S. Morgan Smith Co.

"Grand Coulee Model Pump Investigation of Transient Pressures."

"Vibration of the Grand Coulee Pump-Discharge Lines," by John Parmakian.

"Fuel Trends in the Next Twenty Years."

"Underground Gasification of Coal at Gorgas, Ala."

"Pulverized Coal-Fired Gasifier for Producing Carbon Monoxide and Hydrogen," by P. R. Grossman and R. W. Curtis, Babcock & Wilcox Co.

"The Use of Additives for Prevention of Low-Temperature Corrosion in Oil-Fired Steam Generating Units."

Monday, November 30, 2:30 p.m.

"Performance of the Turbulence Pump," by H. W. Iversen, Univ. of California.

"Fuel-oil Specifications."

"Boiler and Furnace Design for Spreader Stokers."

"Interface Extension vs. Upper Limiting Time-Mean-Energy Release Rates of Constant-Pressure Steady-State Combustion Process," by W. J. Wohlenberg, Yale Univ.

Monday, November 30, 8 p.m.

"Chimney Design," by R. H. Sherlock, Univ. of Michigan.

"Economics of Ash Handling," by L. E. Mylting.

"Electrostatic Precipitators."

"Design of Power Plant Tests."

"Measurement Errors: Classification and Interpretation."

Tuesday, December 1, 9:30 a.m.

"Turbine-Generator Sets for Shipboard Service," by A. G. Gale and H. J. Chase, General Electric Co.

"Turbine-Blade Vibration and Strength," by W. E. Trumpler and H. M. Owens.

"Comparison of Land and Marine Power-Plant Practices," by M. L. Ireland, Jr., F. A. Ritchings, Jr., and Sabin Crocker.

Panel Discussion Covering Use of Residual Fuels in the Gas-Turbine Industry.

Tuesday, December 1, 2:30 p.m.

Panel Discussion on Progress Toward Industrial Atomic Power:

1. "A Reactor Engineer Looks at the Problem."
2. "The Problem from an Economic Standpoint."
3. "The Legal Barrier."
4. "Statement of AEC Policy."

"Manpower and Other Factors Affecting Operating Costs," by V. F. Estcourt of Pacific Gas & Electric Co.

Panel on Above Subject. Participants—J. C. Falkner, Consolidated Edison Co., New York, G. V. Williamson, Union Electric Power & Light Co., St. Louis, J. D. Williamson, Dayton Power & Light Co. and W. V. Drake, West Penn Power Co.

"The Gas Turbine as a Prime Mover in U. S. Navy Ships."

"A 4500-Kw Mobile Gas Turbine Power Plant."

Tuesday, December 1, 8 p.m.

"The Controlled Circulation Boiler," by W. H. Armacost, Combustion Engineering, Inc.

"Controlled Circulation at Chesterfield Station," by T. E. Crossan, Virginia Electric Power Co. and W. F. Ryan, Stone & Webster.

"The New Kearny Generating Station," by F. P. Fairchild, Public Service Electric & Gas Co.

"Reheat Turbines at Chesterfield and Kearny Stations," by C. W. Elston.

Wednesday, December 2, 9:30 a.m.

"Local Boiling Heat Transfer to Water at Low Reynolds Number and High Pressures."

"Kinetic Theory of Evaporation Rates of Liquids."

"Design Calculations for a Tubular Air Heater."

"Heat Transfer and Fluid Friction During Flow Across Banks of Tubes: V-Baffled Exchanger with No Internal Leakage."

"Symposium on Design and Experience with Outdoor Power Plants." Participants—J. N. Landis, Bechtel Corp.; F. W. Argue, Stone & Webster Engineering Corp.; E. C. Duffy, Long Island Lighting Co.; W. F. Friend, Ebasco Services, Inc.; A. B. Martin, Montana Power Co.; and V. F. Estcourt, Pacific Gas & Electric Co.

Wednesday, December 2, 2:30 p.m.

"Air Pollution Controls—In Canada, New York, Great Britain, and Los Angeles."

"Economics of Large Turbine-Exhaust End-Size Selection for Electric Power Generation," by D. W. R. Morgan, Jr., and S. D. Fulton, both of Westinghouse Electric Corp.

"Economic Determination of Condenser and Turbine-Exhaust Sizes," by E. H. Miller, General Electric Co., and A. Sidun, Foster Wheeler Corp.

"A Novel Method of Cooling Gas-Turbine Blades."

"Free-Piston Turbine Compound Engine—A Cycle Analysis."

Thursday, December 3, 9:30 a.m.

"Testing Large Steam Turbines with Weighing Tanks," by W. A. Pollock, Wisconsin Electric Power Co.

"A Short Method for Evaluation of the Effect of Some Terminal Cycle Variations in Steam-Turbine Heat Rates," by S. D. Fulton, Westinghouse Electric Corp.

"The Solubility of Nitrogen and Hydrogen in Water," by W. L. Sibbitt, Purdue Univ.; L. M. Zoss, Taylor Institute Co., and S. Suciu, General Electric Co.

"Catalytic Action in Oxydation of Lubricating Oils."

"Development and Application of Antiwear Turbine Oils," by T. W. Havely and A. R. Black, Shell Oil Co.

Thursday, December 3, 2:30 p.m.

"Piping Flexibility Analysis," by A. R. C. Markl, Tube Turns, Inc.

"Elastic Constants and Coefficients of Thermal Expansion of Piping Materials, Proposed for 1954 Code for Pressure Piping," by Rudolph Michel, Bureau of Ships, Navy Dept.

"In-Plane Bending Properties of Welding Elbows," by P. L. Vissat and

A. J. Del Buono, Taylor Forge & Pipe Works.

"Action of Boiler Water on Steel-Attack by Bonded Oxygen."

"Corrosion of Steel in Boilers—Attack by Dissolved Oxygen."

"Experimental Boiler Studies of the Breakdown of Amines."

Thursday, December 3, 8 p.m.

"Results of Service-Test Program on Transition Welds Between Austenitic and Ferritic Steels at the Philip Sporn and Twin Branch Plants."

"Cyclic Heating Test of Main Steam Piping Materials and Welds at Sewaren Generating Station."

"Stress-Rupture Properties of Some Chromium-Nickel Stainless-Steel Weld Deposits."

"Twelve Per Cent Chromium Alloys for 1000 to 1200 F Operation."

"Effect of Certain Elements on Graphitization of Steel."

Friday, December 4, 9:30 a.m.

"Experimental Superheater for Steam at 2000 Psi, 1250 F," by F. Eberle and F. G. Ely, Babcock & Wilcox Co., and J. A. Dillon.

Among the scheduled luncheons are:

The Presidents Luncheon at 12:15 p.m., Monday, November 30.

Fuels Luncheon at 12:15 p.m., Tuesday, December 1, with J. R. Michel presiding and Alfred Iddles of Babcock & Wilcox Co. speaking on "Power Today and Tomorrow."

The Honors Luncheon on Wednesday at 12:15 with President F. S. Blackall, jr., presiding.

The Members and Students Luncheon on Thursday.

At the annual banquet on Wednesday evening the speaker will be Gwilym A. Price, president of Westinghouse Electric Corp.

The Roy V. Wright Lecture on Wednesday noon will be delivered by Thomas Millsop, president of Weirton Steel Co.

New Books

Any of these may be secured by writing Combustion Publishing Company, 200 Madison Avenue, New York 16, N. Y.

Protective Atmospheres

By A. G. Hotchkiss and H. M. Webber

Based on actual industrial experience, this book by two engineers from the Industrial Heating Department of the General Electric Company, is intended to give information on practical manufacturing operations. An introductory chapter takes up typical protective atmospheres and lists their uses for such industrial applications as annealing, brazing, normalizing, sintering and the like. Basic chemical reactions of gases are then presented, followed by chapters on atmospheres for preventing or reducing oxides and for preventing decarburization. The authors next turn their attention to atmospheres for carburizing, carbon restoration and nitriding. Gas analyzers, controllers and measuring devices are discussed, followed by a chapter on the storage, distribution and handling of gases. Applications are more specifically elaborated in the next-to-last chapter which contains illustrations of representative heat treating equipment and typical finished products. The final chapter contains many remedies for protective-atmosphere ailments plus an extended table, keyed to the rest of the book, which tells what to do when difficulties are encountered.

The book contains 342 pages and sells for $7.

Selected Values of Physical and Thermodynamic Properties of Hydrocarbons and Related Compounds

By the Staff of American Petroleum Institute, Research Project 44

For more than 25 years the American Petroleum Institute has sponsored a program of fundamental research which has determined and correlated data relating to the occurrence, recovery, composition and properties of petroleum. The information resulting from such research ordinarily is not directly applicable to industrial operations or processes but is useful in the planning of new methods of petroleum discovery, production and refining.

API Project 44, entitled "Data on Hydrocarbons and Related Compounds," was begun in 1942 under the direction of F. D. Rossini, who at that time was with the National Bureau of Standards and is now head of the

Department of Chemistry at the Carnegie Institute of Technology. The project serves as the central agency for collecting, calculating and compiling data covering physical, thermodynamic, and infrared, ultraviolet, Raman and mass spectral properties of hydrocarbons and all related compounds. Among the compounds studied are hydrocarbons of all types and molecular weights, organic sulfur and oxygen compounds, simple nitrogen compounds, and certain halogens and halogenated hydrocarbons.

Contents of the book include 747 pages of tables of properties, 191 pages of specific references and 68 pages of general references. There is an index of properties and another listing the compounds whose properties are tabulated.

Among the properties listed are boiling points, heat of combustion, density, enthalpy, entropy, free energy functions, freezing points, heat of fusion, heat of vaporization, index of refraction, kinematic viscosity, surface tension and vapor pressures.

The book which is cloth bound, 8 in. by $10^1/_2$ in., contains 1059 pages and sells for $7.

The Atomization of Liquid Fuels

By E. Giffen and A. Muraszew

Wherever liquid fuel is employed, whether in an internal-combustion engine or a furnace, atomization has most important bearing on the process of combustion. It has long been the subject of much research and numerous reports and papers have been published giving the results of such investigations, but the information is scattered and many gaps exist. Therefore, it was the purpose of the authors to select and correlate such of this information as they considered to be most useful in presenting a comprehensible picture of the mechanism of atomization.

Among the chapter headings are: The Mechanism of Disintegration of Liquid Jets; Fuel Spray Characteristics; Effect of Atomizer on Spray Characteristics, Theory of the Swirl Atomizer; Use of Dimensional Analysis for Correlation of Atomization Data; Effect of Physical Properties of the Liquid on Spray Characteristics; Effect of the Properties of the Injection Pressure; Formation and Development of Intermittent and Continuous Sprays; and Experimental Methods for Assessment of Fuel Spray Characteristics.

Dr. Giffen is professor of civil and mechanical engineering at the University of London and his co-author, Dr. Muraszew, carries the titles of both Ph.D. and Dip.Ing.

Although printed in Great Britain, the book is published in the United

States. Of standard size, it contains 246 pages, well illustrated, and is priced at $6.

An Introduction to Power System Analysis

By Frederick S. Rothe

The field of power system engineering, including the basic tools of analysis developed during the past two decades, is examined in this book which is one of a series written by General Electric authors for the advancement of engineering practice.

The author considers the characteristics of each component in the modern power system, and analyzes those of the generator, transformer, transmission line and the load. While his scrutiny of synchronous machine theory, transformer theory, transmission line theory, symmetrical components, and stability is confined to the problems associated with the fundamental operating frequency, he also investigates the transient behavior of the components during disturbances. His wide experience in the field has enabled him to select the fundamentals and explain them succinctly, as well as to advance the information necessary to solve the majority of problems that arise in practice.

Mr. Rothe is currently manager of control systems in the analytical engineering section of the General Electric Company in Schenectady.

The book contains 187 pages and is priced at $5.

Review of ASTM Research

This 22-page pamphlet, prepared by the Administrative Committee on Research of the American Society for Testing Materials contains summaries of the major ASTM research activities as carried on by its numerous technical committees. These reviews are briefed from the more extended reports which have appeared periodically in the Society Bulletins. Well over three hundred investigations involving some sixty projects are included.

The pamphlet provides a handy reference to what has been done and a key to more detailed information. Copies are obtainable without charge from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pa.

CORRECTION—Our attention has been called to a typographical error in the review of a book by G. M. Enos and W. E. Fontaine on Page 67 of our September issue. The correct title should be "Elements of Heat Treatment."

New Team to Study Nuclear Power

Duquesne Light Company, which serves the Pittsburgh district, and the Walter Kidde Nuclear Laboratories, Inc., of Garden City, Long Island, have entered into an agreement with the Atomic Energy Commission to undertake jointly a study to determine the engineering and economic feasibility of producing electric power from atomic energy. The Commission has agreed, in the interest of forwarding private industrial participation in the Atomic Energy Program, to assist these companies in carrying out this study by giving access to necessary information and making available some of its personnel and that of its contractors for consultation purposes. The purpose and scope of the project is:

1. To determine the economic and engineering feasibility of the design, construction, and operation of a nuclear reactor which can be utilized for the production of electric power for use within Duquesne Light Company territory.

2. To offer recommendations in a report to the Commission concerning this nuclear project and industry's role in undertaking and carrying it out.

In carrying out the agreement, the two companies will investigate nuclear reactors now in operation and under design or construction, and will draw upon the experience of Duquesne Light Company personnel in the field of electric power generation and distribution and of the personnel of Walter Kidde Nuclear Laboratories in the atomic field. The latter was established as one of the first privately-financed atomic laboratories in the United States with a primary objective of developing commercial atomic power. The firm has made independent investigations into the economics of atomic power and it is currently conducting similar studies for the Atomic Energy Commission, according to several releases made available in recent months.

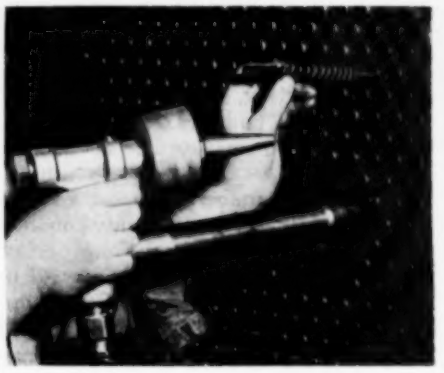
Long Range Viewpoint

Despite the availability of relatively low cost coal in western Pennsylvania, from which all of Duquesne Light Company's electric power is now generated, the company is interested in analyzing the long range possibilities of the economic use of a nuclear reactor for producing electric power in order that it can continue to provide in the future electric service to its customers in the Pittsburgh District at the lowest possible cost.

New Equipment

Tube Cleaner

The Lagonda Division of The Elliott Company, Springfield, Ohio, has developed a new condenser tube cleaner consisting of spirally wound nylon brushes and an improved Jiffy gun. The spiral design of the brushes gives them a spinning, scouring motion which, together with the flushing action of the water from the gun, quickly removes



sludge and other soft deposits from small tubes. The brushes have rubber bumpers or plugs at either end which are of a slightly smaller dimension than the tube to permit the water to pass and impart the spinning action to the brush. Air can be used as the operating medium although water is preferred for its flushing action. Brushes are then recovered at the other end and used over again.

Gage Glass

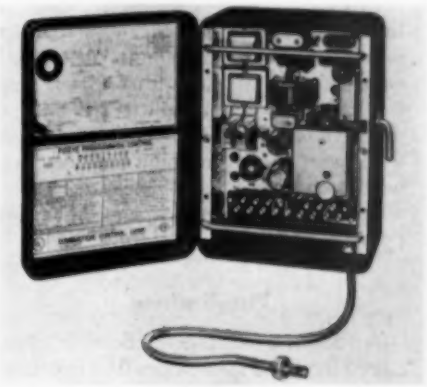
Diamond Power Specialty Corp. of Lancaster, Ohio, has made a new approach to the problem of glass breakage in flat-glass type gages. Instead of using a long slender piece of glass with its attendant high stresses, the glass is divided into a series of short sections, accurately fitted and mounted with thin mica separators in the joints. Serious strains are absent in these short pieces and gage outages due to glass failure have been cut to a fraction.

Safety Valve

The Remotor, a depressurizing safety valve, has been announced by Farris Engineering Corp., Palisades Park, N. J. It is designed for use with pressure vessels in event of an emergency and to function as an unloader for those applications where the unloading feature can be combined with the safety valve. Units are available with standard depressurizing motors in valve sizes from $1 \times 1^1/_2$ in. to $2^1/_2 \times 4$ in. and with extrapower depressurizing motors in valve sizes 3×4 in. to 8×10 in.

Combustion Control

A new Fireye programming control for commercial-industrial gas, oil or combination gas-oil burners has been developed by the Combustion Control Corporation, 718 Beacon Street, Boston Mass. It employs the flame-sensitive



"Fireton" cell to shut off fuel within two to four seconds after a burner flame goes out. This control is a single standard package unit with complete automatic startup, operating and shut-down control for any type of burner. Its fail-safe circuit prevents operation under any unsafe condition. Maximum accessibility and ease of installation are provided by a plug-in chassis.

Steam Trap

Announcement is made by Armstrong Machine Works, Three Rivers, Mich., of a new cast steel side-inlet, side-outlet trap with integral strainer. The material is stainless steel, and the trap is designed for pressures up to 600 psig with a maximum capacity of 4400 lb per hr. Connections are $^1/_2$, $^3/_4$ or 1 in. screwed, flanged or socket weld.

New Catalogs and Bulletins

Any of these may be secured by writing Combustion Publishing Company, 200 Madison Avenue, New York 16, N. Y.

Water Sampling

A new informational leaflet describing some of the factors involved in obtaining useful samples required for proper control of water conditions in a power house has been released by Allis-Chalmers Manufacturing Company. The leaflet which is entitled "Effective Water Sampling" tells which samples are important, when samples should be

taken, where to obtain them and how they should be drawn.

Centrifugal Pumps

Ingersoll-Rand has recently published an 18-page, three-color bulletin (Form 7251) on the Class "CNTA" multi-stage centrifugal pumps. It incorporates sectional drawings, installation views and a two-stage chart showing the unusual amount of interchangeability of parts throughout the CNTA line. These units, specifically designed for boiler feed, refinery, process work and mine pumping services are now available for all pressures from 300 to 1000 psi with capacities to 700 gpm

Pipe Ratings

A 28-page technical bulletin just issued by The Pipe Fabrication Institute contains more than 5000 pressure-temperature ratings of the various grades of pipe in common use in power plants. These ratings have been calculated by the recently revised formula and allowable stress values applying to the ASA Code for Pressure Piping and the ASME Power Boiler Code. They are arranged for easy reference and will eliminate the laborious calculations previously necessary, saving much time both in preliminary studies and in final design.

Testing Instruments

A buyer's guide on electric testing ,nstruments has been announced as available from the General Electric Co. The 16-page bulletin, designated GEA-5469B, provides data on such instruments as hook-on volt-ammeters, hook-on wattmeters, hook-on power-factor meters, portable recorders, voltmeters and ammeters, phase-sequence indicators, hand pyrometers, surface roughness scales, insulation-resistance meters, and others. Application data, features of each instrument, and prices are included.

Weld Strength Calculator

A unique weld strength calculator has been made available by Lukens Steel Company. A companion tool to Lukens' plate size selector, the weld strength calculator is a durably-made plastic slide rule that indicates both the size of weld required for a given applied load, and the weight of a given length of weld in pounds. The calculator gives values for stresses ranging from 2000 to 20,000 psi, and applied loads of from 9000 to 450,000 lbs. On the reverse side of this pocket-size calculator are basic design data for welded connections and formulas for calculating nominal properties.

Flow Meter

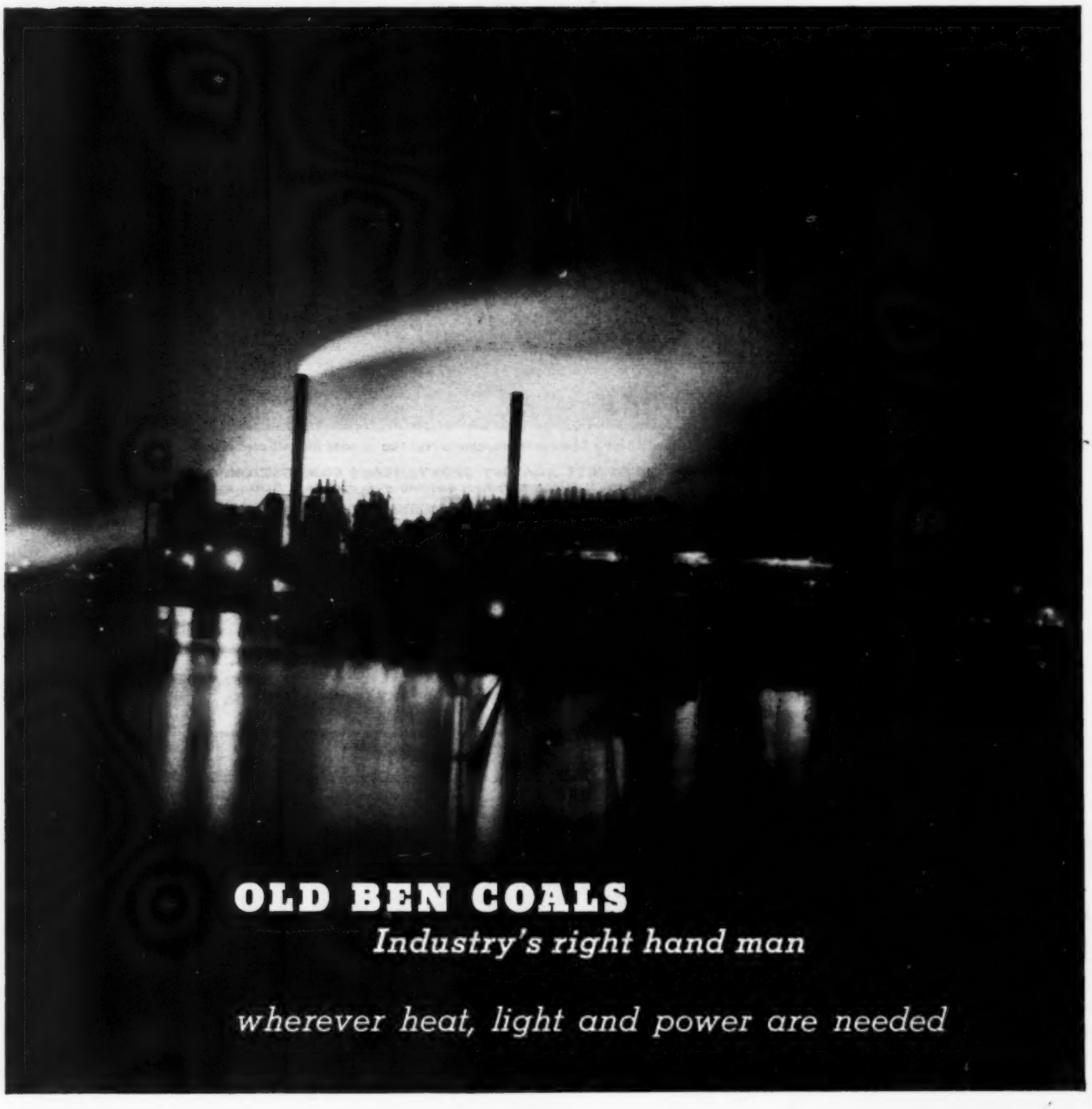
Simplex Valve and Meter Company has prepared a 16-page bulletin (No. 500) describing the Type MO flow meter. The bulletin contains data on the operation, construction, accuracy and associated devices for this Venturi type meter. General information is also provided on head losses, methods of transmission and mountings. A capacity table is included.

Silicone Products

A reference guide on silicone products has been prepared by the Dow Corning Corporation. It lists catalogs and publications pertaining to the silicone fluids, adhesives, water repellents, protective coating resins, defoamers and other products

Special Products

Johns-Manville has issued an eight-page catalog entitled "J-M Products for the Process Industries" which can serve as a ready reference for those who design, install and operate process equipment. Products covered include industrial insulating materials, refractories insulating brick, Transite pipe, acid and caustic-resisting packings, gaskets and Raschig rings.



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